CONTROL OF PHANEROGAMIC PARASITES INFESTING MANGO

BY

RASHMI C. R.

THESIS
submitted in partial fulfilment of the requirement
for the degree
MASTER OF SCIENCE IN AGRICULTURE
(AGRONOMY)
Faculty of Agriculture
Kerala Agricultural University

Department of Agronomy
COLLEGE OF AGRICULTURE
Vellayani, Thiruvananthapuram

1993

Dedicated to

my loving parents

DECLARATION

I hereby declare that this thesis entitled CONTROL OF PHANEROGAMIC PARASITES INFESTING MANGO, is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

College of Agriculture,
Vellayani,
23-12-1993.

RASHMI. C.R.

CERTIFICATE

Certified that this thesis entitled **CONTROL OF PHANEROGAMIC PARASITES INFESTING MANGO**, is a record of research work done independently by Miss. **RASHMI, C.R.** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

College of Agriculture,
Vellayani,
23-12-1993

Dr. M. OOMMEN,
Chairman,
Advisory Committee
Professor,
Instructional Farm

APPROVED BY:

CHAIRMAN :

Dr. M. OOMMEN

MEMBERS :

1. Prof. P. CHANDRASEKHARAN
2. Dr. (Mrs.) P. SARASWATHY
3. Dr. S. SHESHADRINATH

EXTERNAL EXAMINER :

(S. D. SUNDARSINGH)

ACKNOWLEDGEMENT

I wish to express my deep sense of gratitude to Dr. M. Oommen, Professor, Instructional Farm and Chairman of my Advisory Committee for suggesting the problem, for his persisting encouragement, sincere help, goodwill and gesture of affection rendered to me throughout the course of this investigation and preparation of the thesis.

I am thankful to Sri. P. Chandrasekharan, Professor and Head, Department of Agronomy, Dr. (Mrs.) P. Saraswathy, Associate Professor (Hr. Gr.) and Head, Department of Agricultural Statistics and Dr. S. Sheshadrinath, Professor of Plant Physiology, members of the Advisory Committee for their timely suggestions and valuable help at all stages of the study.

I would like to specially thank Dr. Kuruvilla Varghese, Associate Professor (N.C.), Department of Agronomy, for his sincere help, everwilling attitude, critical and sound suggestions during the preparation of the thesis. His valuable comments on the whole manuscript have led to considerable improvements in this thesis.

I am thankful to Dr. S. Bhaskaran, Professor, Department of Agricultural Extension for the sincere help extended to me for the survey work. I am also indebted to Dr. Naseema Beevi, Associate Professor, Department of Entomology for her unstinted help during the residual analysis.

I express my deep sense of gratitude to Sri. C.E. Ajithkumar, Programmer, Department of Statistics, College of Agriculture, Vellayani for the pains he has taken in computer programming and analysis of the data. I also thank M/s. Athira Computers, Kesavadasapuram, Thiruvananthapuram for neatly typing the thesis.

I take this opportunity to express my thanks to the teaching and non-teaching staff, my classmates, senior and junior students of Department of Agronomy, College of Agriculture, Vellayani for all the co-operation and help rendered to me.

I owe deep sense of gratitude to my room mates and friends of the Ladies Hostel, College of Agriculture, Vellayani for their whole hearted support, love and affection all throughout.

I would like to thank the USDA Forest Service for providing me with the literature.

My sincere thanks are also due to the labourers who helped me during the course of work.

I herewith take the opportunity to express my deep sense of obligation to my parents, grand mothers, sister and brother, without whose unstained support, prayers and sacrifices this endeavour could not have ever seen light. My feelings towards them cast beyond expression.

Above all, I bow my head before God Almighty whose blessings were always with me, enabling me to undertake this endeavour successfully.

RASHMI. C.R.

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

INTRODUCTION

1. INTRODUCTION

Mango (*Mangifera indica*) is the most important fruit tree in tropical and subtropical regions of the world. It is grown in about at least 87 countries but nowhere it is so greatly valued as in India, where it occupies 70 per cent of the area devoted to fruit crops. It is cultivated throughout India both in hills and the plains. The largest genetic diversity in mango is also found in our coutry. However, this "King of fruit" trees is severely infested with certain phanerogamous parasitic weeds viz., Loranthus. This obnoxious parasitic weed infects the mango tree both in homesteads and in large orchards. In northern India 60 to 90 per cent of the trees are heavily or moderately infected with this parasite. (Singh, 1983).

Phanerogamic parasites have a serious impact on the productivity of the host tree. Economic impact of Loranthus infestation on host trees is due to the qualitative and quantitative deterioration viz., the reduction in tree vigour, poor fruit setting and drying of branches. If not attended in time, under severe infestation, complete damage of the host tree may also occur. In the early stages the effect of infestation is not at all marked, but as the parasite gains vigour and spread, it gradually suppresses the host. The most destructive species of Loranthus infesting the mango tree is _Dendrophthoe_ _falcata_. (Fischer, 1926). In addition to this five other species of Loranthaceae viz., _Macrosolon_ _cochinchinensis_, Van Tiegh., _Elytranthe_ _capitellata_ Engl., _Helicanthes_ _elasticus_ Dans., _Viscum_ _articulatum_ Burm., and _Viscum_ _monoicum_ Roxb. are also reported to parasitize mango tree (Fischer, 1926).

The severity of damage caused by these parasitic shrubs has however, not been adequately realized in India. Only little effort was taken to assess the quantitative and qualitative loss caused by the parasite in mango and other fruit trees. The commonly known method of control is the lopping off of the infested branches. In horticultural plantations, eradication of the parasite is carried out along with the annual pruning programme. However, this method resulted in the removal of a lot of branches of the host tree and a great loss of canopy. On complete removal of the vegetative growth of the parasite also, a rejuvenation from the vestigia of embedded haustorial system was observed. In certain host trees like teak (_Tectona_ _grandis_) and other timber trees, the spraying and injection of herbicidal formulations like 2,4 - dichloropropionic acid, metribuzin, etc. are reported to control the parasite. (Nair, 1965; Ghosh, 1983).

With the above background a survey was conducted at four mango orchards of Southern Kerala (Vellayani, Peringamala, Anchal and Mavelikkara) to assess the damage of Loranthus infestation. Experiments were also conducted at Instructional Farm attached to the College of Agriculture, Vellayani with the following objectives.

1) To suggest an effective cultural control measure against the Loranthus infestation on mango trees.

2) To identify suitable herbicide for the control of Loranthus in mango trees.

3) To standardise an effective method of application of herbicide to control the phanerogamic parasite in mango trees.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Loranthaceae is an order of hemiparasitic shrubs having green leaves, but derives a considerable portion of its nourishment from the tissues of the host tree to which they are attached by modified roots. Members of the family Loranthaceae, popularly known as "Loranthus" or "mistletoes" are the most destructive parasites of tree crops in the tropics (Balasundaran & Mohammed Ali, 1991). Inspite of the fact that all the mistletoes take a heavy toll in horticulture and forestry, very little attention has been paid in India, to control these parasites systematically (Ghosh et al, 1984). Studies relating to the epidemological factors, biology of the parasite, host pathogen relationship, biochemical aspects of parasitism and control are very meagre. The current state of knowledge on these aspects will be reviewed here.

2.1. Distribution of Loranthus and its host plants

In India, the first report on the appearance of Loranthus in teak plantations was made by Cleghorn in 1867, and later as reported by Lushington (1898).

In India, several species of mistletoes have been recorded on various forest and fruit trees (Brandis, 1907; Rao

1923; Singh 1962; De 1945) observed that mistletoes are highly host selective.

Johri and Bhatnagar (1972) listed 343 hosts for _Dendrophthoe falcata_ in India which included several common horticultural and forest trees.

Mistletoes are one of the earliest parasites of plants recognised by Albertus Magnus around 1200 A.D. (Horsfall and Gowling, 1977).

Sridhar _et al_. (1978) observed that _Dendrophthoe falcata_ was a menace to orchards, which severely infected the branches of _Achras sapota_ (Sapota) and _Vitis vinifera_ (Grape vine).

Balasundaran (1984) reported that the species of Loranthus found in India include _Dendrophthoe falcata_ var. pubescens, attacking _Tectona grandis_ (Teak) plantations and other tree species, _Helicanthes elastica_ on _Mangifera indica_ (Mango) _Anacardium occidentale_ (Cashew), _Hevea brasiliensis_ (Rubber) _Citrus Spp_ (citrus), _Artocarpus integrifolia_ (Jack tree), _Achras sapota_ (Sapota) and _Macrosolon parasiticus_ on Citrus, Jackfruit tree and _Acreuthobium_ spp. on conifers in the Himalayas.

Ghosh _et al_. (1984) recorded that _D. falcata_ (Linn. f) Ettingh. var. pubescens Hook.f. is the most common mistletoe in Kerala. He has also observed that _Helicanthes_ elastica is the most common species attacking mango trees. D. falcata was found on teak, Dalbergia latifolia (Indian Rosewood tree), Psidium guavajava (guava) and Bombax ceiba

It was reported that mistletoes severely infected the citrus and guava orchards in central Sudan (Osman 1984) and the Orchids in Costa Rica and Ecuador (Kuijit et al. 1985).

Alam (1987) reported that D. falcata and Viscum monoicum causing serious damage in Teak and Mango.

Dendrophthoe falcata was found to attack Boswellia serrata in Jhalana Hills of Rajasthan. (Sharma, 1990).

Rao et al. (1991) noticed the attack of D. falcata Piper betle (betel vines) around Bangalore area.

Termenalia arjuna (Arjun) and Populas deltoides (Poplar) were noticed as the new host trees for D. falcata (Singh et al, 1991).

2.2. Flowering and Seed Dispersal of the Parasite

In D. falcata, the main flowering season is from December to April. During March- April large quantity of its fruits are seen in tree crops of Kerala. (Ghosh et al., 1984).

Balasundaran and Ghosh (1986) reported that the flowering season of <u>Macrosolon parasiticus</u> and <u>Helicanthes elastica</u> is from May to July in Kerala. Clumps of these parasite reappear due to freash infestation during profuse flowering and fruiting period of parasite.

Ali (1931) found that birds are the main agents of pollination and seed dispersal in Loranthus. He has also observed that <u>Dicaeum erythrorhynchus erythrorhynchus</u> (Tickell's flower pecker) was the most common bird in dispersal of its fruits.

Bakshi <u>et al</u>. (1971) opined that dwarf mistletoes are equipped with the mechanism of explosive ejection of seeds in addition to the agency of birds. However, the explosive ejection helps only the localised spread of the parasite.

Davidar (1978) reported <u>Dicaeum concolor</u> as the most common bird dispersing mistletoe seeds in Nilgiris. Fruits of <u>Macrosolon parasiticus</u> are also dispersed by fragivorous birds such as bulbuls and barbets.

2.3. Host - Parasite Relationship

Singh (1954) reported the presence of primary and secondary haustoria in <u>D. falcata</u>

Singh (1962) and Kuijit (1969) reported that "holdfast", a part of the haustorium functions in the attachment of the haustorium to the host.

Small portion of the host gets embedded in the haustorium, in D. falcata. Singh, (1952) stated that the intrusion of these host masses into the parasite body was a clear indication of the reaction of the host to the penetrating haustoria.

Thoday (1961) made a general survey of the union and interaction between the host and parasite in Loranthaceae. He observed that the haustorium generally invades the cambium of the host and establishes contact with the wood of the host and then the host and parasite grow together.

Srivastava et al. (1961) indicated that in Phloem deficient dwarf mistletoes, their close association with the host and sinker parenchyma facilitates organic solute uptake. Easu (1969) reported that except in Viscum minimum, there is no connection between host and parasite phloem.

In mistletoe parasitism, water conducting pathway is characterised by a great xylem to xylem contact, co-ordinated growth of the host and the parasite, xylem, an apoplastic continuum between the host and the parasite and in some cases parasite development within radial as well as axial translocating system. (Fisher, 1983).

2.3.1. Biochemical relationship of host and parasite.

Surya Prakash (1967) opined that the leaves of D. falcata growing on different trees varied in dry solid contents. Total phosphorus in leaves of D. falcata attacking mango was found to be 2.43 mg/g dry wt. and that parasitizing Anona squamosa, Cassia seamia and guava were 1.51, 3.51 and 4.96 mg/g dry wt. respectively.

Govier et al. (1967) in their studies on the hemiparasitic nutrition in angiosperms found that in association with a host assimilation of nitrate by hemiparasite roots was supplemented by absorption of amides, aminoacids and other metabolites elaborated in the host.

Johri and Bhatnagar (1972) opined that the outer zone of epidermis of D. falcata consists of six or eight layers of dense tannin filled cells packed with starch. The xylem cells of the root also contain starch frequently.

Physiological studies of parasitized branches of mango have shown the D. falcata obtained water and minerals from the host. (Kumar et al., 1973)

Fer (1981) reported that in cuscuta, carbohydrates were absorbed from the host phloem, mainly as sucrose or as a sucrose analogue. Aminoacids were also taken up from the phloem, whereas water was absorbed principally from the xylem of the host.

Onofeghara (1981) found that mistletoes act as sink for the photosynthetic products of the hosts and depend entirely on the hosts for water and mineral nutrients.

Concentration of K in various parts of the mistletoe Amyema preissi was higher than in its major host Acacia acuminata while concentration of N showed not much variation, there by mistletoes significantly drained the mineral content of the host. (Lamont, 1982).

Aber et al. (1983) suggested that sucrose could be the main metabolite involved in the transfer of organic substances from host plant to parasite.

Ebleringer et al. (1985) concludes that mistletoes are primarily nutrient parasite differing in their water use efficiency related to that of their host, depending on the host N supply in the transpiration stream.

Stomàtal conductance and transpiration rates were consistently higher in parasite than the host, but assimilation rates did not differ significantly between partners, while the water use efficiency was low in parasites (Davidson et al., 1989).

Marav'eva *et al*. (1990) found that leafy shoots of mistletoes regardless of the host, contained 4.4% water soluble polysaccharides, 2.2% pectin and 34% hemicellulose.

Rey *et al*. (1991) revealed that the endophytic tissues of dwarf mistletoe were richer in S, P and K than the neighbouring host tissues. It was concluded that the mineral elements as well as organic compounds can be withdrawn from both xylem and phloem of the host by the haustoria of the parasite.

2.4. Effect of parasite on the host

According to Singh (1962) who studied various aspect of parasitism and control of *D. falcata*, noticed that the haustoria of the parasite absorb the nourishment from the host starving it partially or completely resulting in the loss of its fruiting ability.

Stewart (1978) reported that in U.S.A alone the estimated annual loss due to mistletoes was about 7.5 million cubic metre of timber.

Johnson *et al*. (1981) estimated that the annual loss of lodge pole pine due to mistletoe attack was equivalent to the annual harvest of saw timber or at least 25 per cent of its annual growth.

Onofeghara *et al*. (1981) noted that considerable damage to the hosts including physical disorganisation, crushing, distortion and discoloration of host tissues adjacent to and remote from the site of entry was caused due to mistletoe.

Parasitic plants also induce disease by penetration of the host and by producing harmful hormones and hormonal imbalances. They also cause a reduction in root sugar, leading to reduced nitrogen which in turn leads to further sugar reduction (Knutson, 1983)

Hawksworth (1983) reported that the economic impact of mistletoes might be quantitative and qualitative including reduction in tree vigour and growth increment, poor fruit and seed setting, poor timber quality, drying of branches and even the death of the entire host tree.

Knutson (1983), found that the wood of older infections by mistletoe become rubbery and weakened which leads to secondary infection by insects and microorganisms.

Singh (1983) reported that mango trees are the worst su fferers from the parasite *D. falcata*. In North India 60 to 90 percent of mango trees and a number of other trees are heavily or moderately infected by *D. falcata*. Beyond the point of attack, fresh growth of the host shoot becomes stunted. The quality and yield of fruit was also considerably lowered. Leaves may be reduced in size and may show unhealthy green colour.

Ghosh et al. (1984) observed that at Nilambur teak plantation D. falcata infestation and mean number of clumps were more at older plantations as compared to younger ones. This might be due to the preference of birds to frequent the older trees with bigger canopy more than smaller ones.

Gnanaharan et al. (1983) reported that the parasite, D. falcata affects the quality of timber in teak.

Osman (1984) noted that the Loranthus spp. (Loranthus) removes bulk of the nutrients from the host and kills the portion of the branch lying beyond the infection. It also upsets the balance of normal substances of the host in the infected area and cause hypertrophy and hyperplasia of the cells with resulting swellings and deformities on the branches.

Eastern dwarf mistletoe, Acreuthobium pusillum reduces timber volume through tree and branch mortality, causes decline in growth, reduces seed production, causes alterations in nutrient contents and induces malformation of stems. (Singh and Carew, 1989)

Mathiasen (1990) reported that the mortality of Pseudotsuga menziesii (Douglas fir) in stands severely infested with <u>Acreuthobium douglasii</u> (dwarf mistletoe) was three to four times more than that of the healthy stands.

Pundir and Mishra (1979) reported that the common features of <u>Cryptolepis buchanani</u> parasitised by <u>Scurlla pulverata</u> are the death of extremities of the parasitised branches of the host and hypertrophy of the parasitised tissue.

2.5. Management of Mistletoes

2.5.1. <u>Silvicultural control</u>

Lushington (1898) reported that removal of <u>D. falcata</u> was practised in Nilambur teak plantations by lopping off the infested branches.

De (1941) and Davidson (1945) recommended lopping or pruning off mistletoe infested branches in Sal forests as a control measure against mistletoes.

Kuijit (1955) suggested that pruning was an uneconomical control measure in large scale forest management. However, it was found worthy for orchards and high value trees.

Agrios (1969) found that the only means of controlling mistletoe in central Sudan is by physical removal of the parasite. Besides being tedious and time consuming, this method of control leads to the deterioration of the fruit trees.

Johri et al. (1972) noticed a great disadvantage of the physical removal or pruning of the parasite due to its regrowth from the small stubs left *in situ* in the host. Since the haustoria survived in the host for a considerable time even after the absence of aerial parts.

Heidmann (1977) recorded that the removal of all infested branches and severely infested younger trees was an effective method of control against mistletoe.

Hawksworth (1978) reported that the features that make dwarf mistletoes (Acreuthobium Spp) amenable to silvicultural control are, as obligate parasites they die with their hosts, their host specificity, long life cycle frequently four to six years, slow rate of spread generally one to two feet per year and the fact that as non-microscopic organisms they are readily detectable.

In the case of dwarf mistletoes control of the parasite was achieved by removing the infected over-story trees, thinning out the infected trees or by pruning the infected branches (Scharpf et al., 1978)

Parker and Wilson (1985) reported that pruning was most commonly used to remove the parasite but complete control was obtained by removing the host branch on which it was growing.

2.5.2. Chemical control

Muthanna (1955), suggested that injection of chlorinated phenoxy acetic acid into trunks of various hosts including mango, gave excellent control of Loranthus.

Seth (1958) found that spray of ammonium Sulphate, potassium dichromate, copper sulphate, and 2, 4--dichloropropionc acid (2, 4-D) against D. falcata on various trees produced varying degrees of harm on host also.

Nair (1965) reported successful control of Loranthus elasticus parasitizing mango tree by single application of 0.4 percent 2, 4-D solution.

In North America, India and Australia limited attempts have been made to check mistletoes by chemical control (George, 1966; Hawksworth, 1983)

Bayer et al. (1967) reported satisfactory control of mistletoe by application of atrazine even after 5 years with no herbicide symptoms expressed on host trees.

Leonard (1972) revealed that atrazine applied as one per cent spray in emulsion oil (six per cent) killed 50 to 60 percent of green mistletoe on Juglans californica (California walnut)

Frochot et al. (1983) pointed out the efficiency of herbicides like glyphosate, and MCPB against mistletoes.

Balasundaran and Ghosh (1986) pointed out that, in general, spray method is not very useful due to the incomplete parasite control and harmful action on the host.

2.5.2.1. Padding

Gopalakrishnan et al. (1979) developed an innovative method for the control of mango stem borer. The method is known as padding in which a piece of bark was removed to the size of 5cm x 5cm area in the trunk and a layer of absorbant cotton was placed and about 10 ml monocrotophos was poured till it was absorbed in the cotton. The bark was then replaced in the same area and covered with wet earth.

Natarajan (1990) also reported that padding with monocrotophos was effective in controlling woolly aphis in apple.

2.5.2.2. Infusion by trunk injection

Kadambi (1954) introduced coppersulphate and 2, 4-D into Dalbergia sissoo (Sal) infected with Scurulla _pulverulenta_ through holes bored around the trunk and reported that the technique was effective in other trees also.

Nicholson (1955) reported control of mistletoes in Eucalyptus is possible by trunk injection of 2, 4-D.

Seth (1958) injected different dozes of ammonium sulphate, copper sulphate, sodium chlorate, Potassium dichromate 2, 4-D etc. into various hosts against _D. falcata_. The result of infusions were not of uniform order as some of the chemicals showed harmful effects on host.

In Australia, control of mistletoes on Eucalyptus by injecting 2,4-D into the tree trunks has been recommended by Brown and Greenham (1965).

Leonard _et al_. (1966) recorded from glass house studies that application of herbicides on bark was superior to foliar application.

Gregory _et al_. (1973) found that all injected trees were safe even after 3 years and many of the wounds were healed up or were in the process of healing.

Prasad (1975) did not find any undesirable impact of injections on large elm trees treated to control the Dutch elm disease. Neither the pressurised injections nor the wounds created by the injector heads had major deleterious effect on the growth and anatomy of the trees.

Ghosh et al. (1980) developed a cheap infusion device for infusing water soluble dye into the teak. It was possible to infuse one litre of water soluble dye into the tree within 1.5 to 2 hours.

Ghosh et al. (1983) found that infusion of metribuzin selectively controlled the parasite *D. falcata* on *Bombax ceiba*.

Balasundaran and Ghosh (1986), screened 19 herbicides using tree infusion technique, of which dalapon, metribuzin and paraquat gave encouraging results.

Ghosh et al. (1988) described the advantages of infusion technique as it minimizes the wastage of chemical and checks the pollution problem. They developed a score card to record relative effectiveness of the chemicals on the host as well as parasite. According to them, a chemical was rated mildly effective, when yellowing of leaves was observed in the parasite, moderately effective when wilting of leaves, young shoots and flowers followed by heavy defoliation in parasitic plants. A chemical was found highly effective when the whole parasitic clump was dried. Studies showed that atrazine and simazine were not effective against the parasite, D. falcata.

Minko and Fagg (1989) opined that glyphosate diluted 1:3 in water injected at the rate of one ml per cut with cuts spaced at 10 cm apart around the lower bole of the tree, controlled Amyema spp. in Eucalyptus

Land - Hoie et al. (1990) noticed that the herbicide, viz., imazapyr was more suppressive than glyphosate towards both stump and root suckers when applied to prevent regrowth of suckers.

Litcher et al. (1991) reported variable results after treating with 5% glyphosate following pruning of mistletoes (0-100% re growth) in land scape trees.

2.6. Residual toxicity in fruits

Luckwill et al. (1960) reported that at normal rates none of the herbicides commonly used in fruit crops are likely to be present in detectable amounts in the fruit at harvest.

Thomas *et al*. (1960) found no injury or phytotoxic symptoms to immature and bearing mango trees when paraquat (5 lbs per acre) and simazine (16 lbs per acre) was applied.

Jordan *et al*. (1968) revealed that residues of bromacil and simazine were not detected in citrus fruits by current method of analysis.

Saiva raj *et al*. (1982) found mango fruits are safe for consumption after 55 days of application of insecticides sevimol, fenthion and formothion.

Reghupathy (1989) studied effectiveness of trunk implantation method of monocrotophos against sucking pests affecting coffee. Residue analysis revealed that monocrotophos residues were below detectable limit in pulp, parchment and coffee powder and this could be due to the long time interval available between application and harvest of berries (3 months).

Though mistletoes poses a great problem to horticultural as well as forest trees, it failed to attract the attention of scientists working all over India. Very little efforts have been taken to find out the qualitative and quantitative losses due to the attack of this parasite. Lopping off the individual infested branches, is a common means of control measure but is difficult to practice due to various administrative and economic problems. No single effective control measure against the parasite has ever been suggested. But recent technique of injecting herbicide viz. metribuzine, paraquat etc through tree trunks has evoked encouraging results. The technique deserves wider investigation with different herbicides on various host trees.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The present investigations were carried out with an objective to identify the common phanerogamic parasite of family Loranthaceae in Mangifera indica (mango tree), and to suggest its control measures.

The details of the survey and the experiment are given below.

3.1. Experimental site

The experiment was conducted in the mango progeny orchard attached to the Instructional Farm, College of Agriculture, Vellayani. The farm is located at 8^{o} 18' N latititudes and 76^{o} 51'E longitude at an altitude of 29 m above MSL. The trees were of the age 28-29 years. Varieties grown in the orchard were of Chandrakaran, Bangalora, Vazhapazhuthi, Jehangir, Neelamundappa, Banganappalli, Neelum, Alphonso, Mulgoa, Kurukkan, Priyoor and Olour. Ninety per cent of the trees were infected with Loranthus.

3.2 Period of study

The survey was conducted during the period of April 1992 to December 1992, while the field study was conducted during the months of August 1992 to February 1993.

3.3. Weather conditions

The weather conditions viz. maximum and minimum temperature, rainfall and relative humidity during the study period and of the past five years were recorded from Agricultural Meteorological observatory attached to the Department of Agronomy, College of Agriculture, Vellayani. (Fig: 1 & 2).

3.4. Materials

3.4.1. Tree Infusion Device

The device consisted of a locally fabricated metallic nozzle which was tightly screwed into the hole drilled in the sapwood of the tree trunk at a height of about one metre above the ground surface. This nozzle was connected to a plastic reservoir of 500 ml capacity through a pressurised polythene tube with a dripping device and regulator cock. The reservoir was tied up about one metre above the nozzles, so that the herbicide solution flows down to the nozzle through the tube. (Fig: 3)

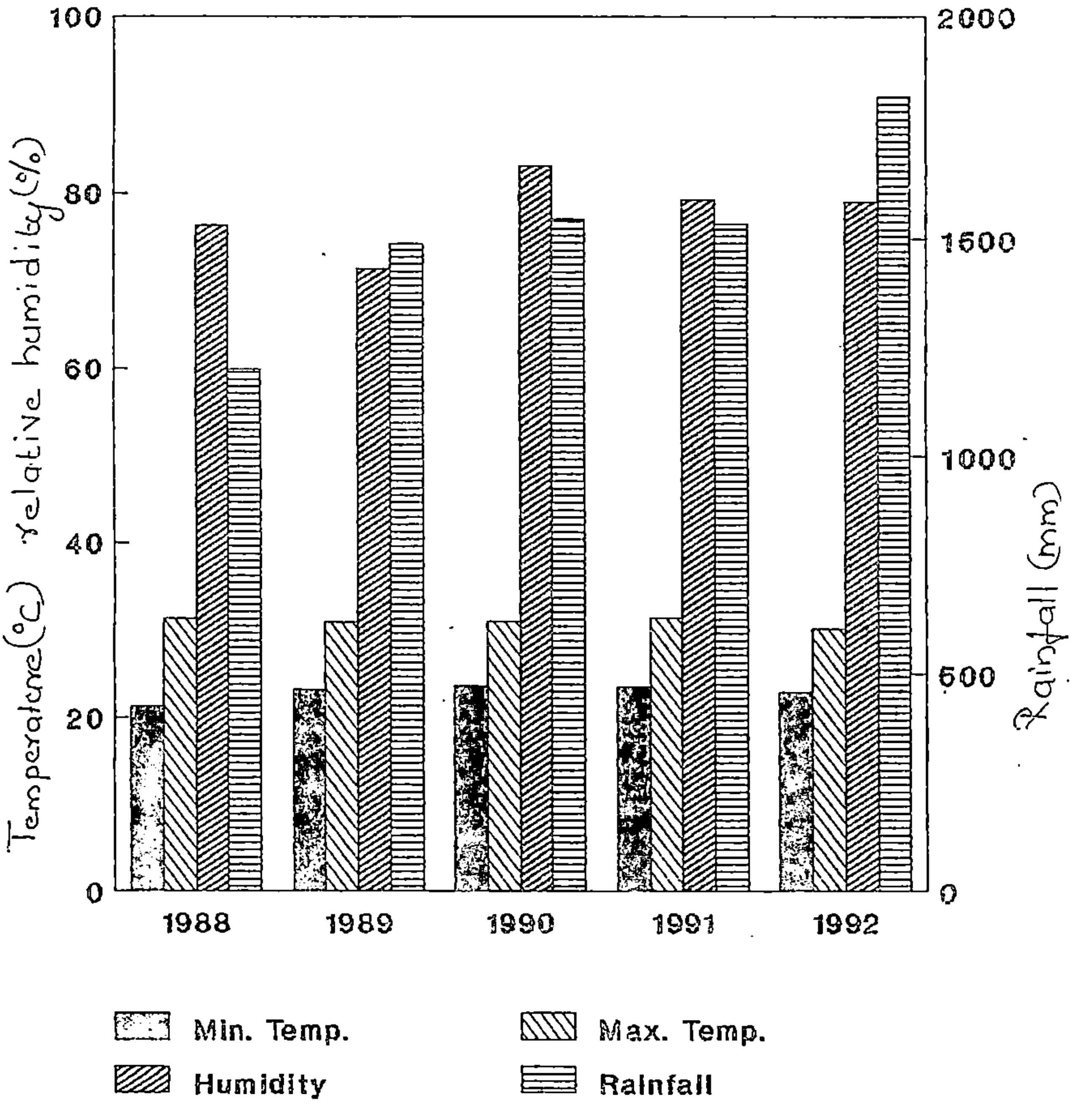

Fig. 1. Weather conditions during the past five years from 1988 to 1992 of Vellayani

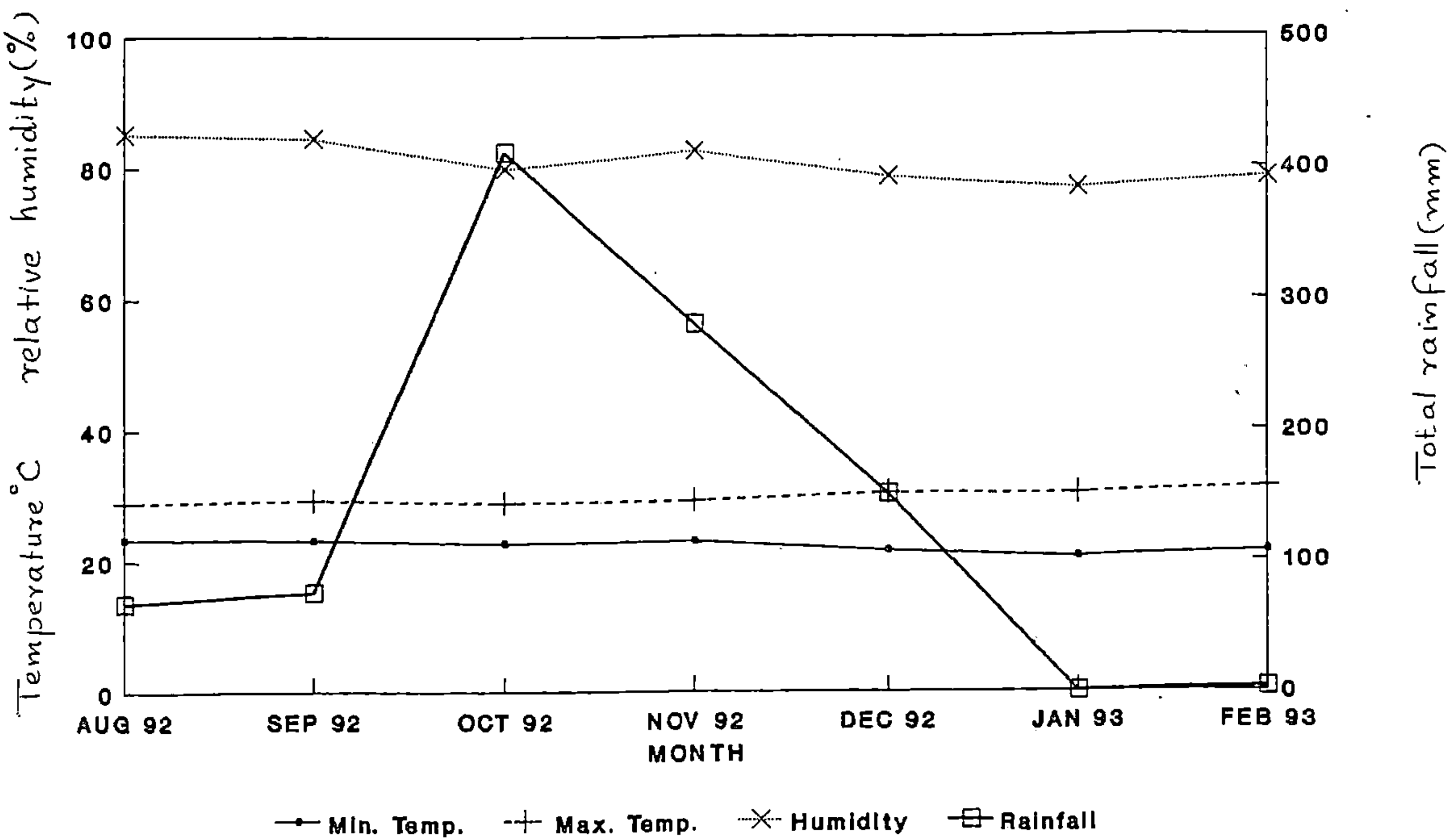

Fig. 2. Weather conditions during the period from August 1992 to February 1993 of Vellayani

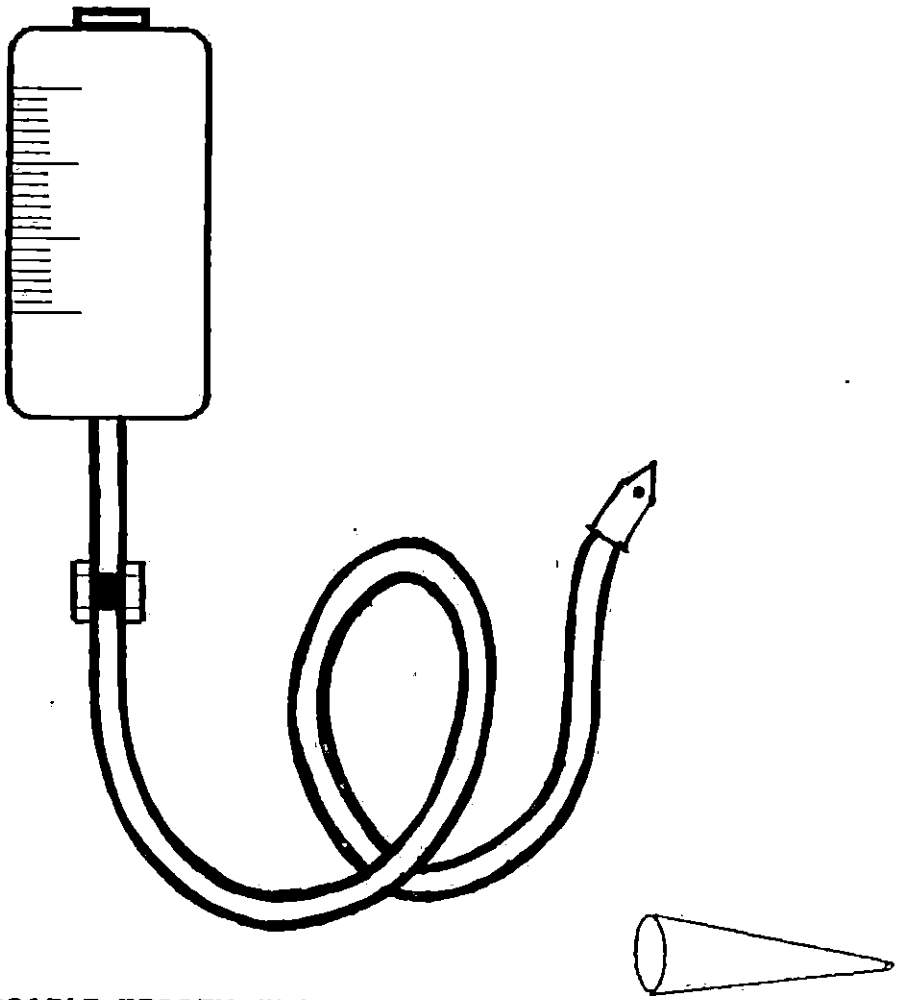

Fig. 3. INFUSION DEVICE

3.4.2. Herbicides used

Sl. No.	Trade Name	Chemical Name/ formula	Manufacturer/ Dealer
1.	Atrataf 50 WP	Atrazine 2-chloro-4-ethylamino -6- isopropylamino -S-triazine	Rallis India Ltd.
2.	Glycel 41% S.L	Glyphosate N-(Phosphonomethyl) glycine	Excel Industries Ltd.
3.	Dalapon 80% WP	2,2 Dichloro propionic acid	Mysore Agrochemicals
4.	Tafazine 50WP	Atrazine 2-chloro-4-ethyl amino-6-isopropylamino -S- triazine	Rallis India Ltd.

3.5. Experimental Procedure

3.5.1. Survey

To get the information on commonly occurring phanerogamic parasites on mango trees and its relative infection and economic damage on different varieties, a survey was conducted during the course of study. For the survey four locations viz. Instructional Farm, attached to the college of Agriculture, Vellayani and District Agricultural Farms at Peringamala, Mavelikkara and Anchal were selected.

3.5.2. Field experiments

The field experiments were conducted at the Instructional farm attached to the college at Agriculture, Vellayani.

3.5.2.1. Cultural method

Complete removal of parasite from infected branches selected at random was done according to the treatments given below. A sharp cut was made at the base of the parasite with a knife for its removal.

Design : Randomised Block Design.

Replication : 6 (single tree)

Treatment : 3

T_1 : Clearing of the parasite once in three months

T_2 : Clearing of the parasite once in six months

T_3 : Unweeded control

3.5.2.2. Chemical Method

Chemical method of control was carried out in two ways viz., (1) padding (2) infusion.

3.5.2.2.1. Padding

A square shaped cut of six to eight cm deep was made on the bark of the tree, one metre above the ground level. Herbicide solutions at the recommended rates were prepared, and a square shaped piece of sponge was dipped in the chemical and kept in the cut made on the tree. The sponge was then covered with a polyethylene sheet to avoid washing out of the chemicals during rains.

3.5.2.2.2. Infusion

In this method, the infusion device as described in 3.4.1 was used. The chemical solution was filled inside the reservoir and allowed to drip into the nozzles drilled into the sapwood, one metre above the ground level.

Design : Randomised Block Design.

Replication : 3

Treatments : 9

C_1 - simazine

C_2 - atrazine C_3 - glyphosate

C_4 - dalapon C_0 - control

m_1 - Padding m_2 - Infusion m_0 - Control

C_1m_1 - Padding with simazine

C_1m_2 - Infusion with simazine

C_2m_1 - Padding with atrazine

C_2m_2 - Infusion with atrazine

C_3m_1 - Padding with glyphosate

C_3m_2 - Infusion with glyphosate

C_4m_1 - Padding with dalapon

C_4m_2 - Infusion with dalapon

C_0m_0 - Untreated Control

3.6. Observations recorded

3.6.1. Number of branches affected by the parasite

Number of branches of the host affected by the parasite was counted.

3.6.2. Girth of branch of the host

Girth of three host branches selected randomly was measured and the mean value expressed in centimetres.

3.6.3. Number of infestations

Total number of infestations in the randomly selected branches were counted before and after the treatment.

3.6.4. Number of haustoria in each infestation

Number of haustoria in each infestation before and after the treatment was counted from three randomly selected branches.

3.6.5. Spread of each infestation

Length of spread of each infestation on host branches was measured with a metre scale and expressed in centimetres.

3.6.6. Biomass

Biomass of the parasite from each treatment was calculated from the total dry weight of the parasite and expressed as Kg per tree.

3.6.7. Rejuvenation Spread

Observation on newly emerged parasitic plants was taken at three and six months after the treatments

3.6.8. Visual symptoms of toxicity

In the case of chemical method visual symptoms of toxicity on the host plant was recorded after the treatment.

3.7. Sampling Procedure

Samples were collected randomly from all the replications. The samples were sun dried, and then dried in a hot air oven at 70 ± 5°C. After drying samples were powdered and used for chemical analysis.

3.8. Plant analysis

3.8.1. Total Nitrogen (N) Phosphorous (P) and Potash(K) content of the parasite

Total N content was estimated by the modified Microkjeldahl method (Jackson, 1973). Total P was obtained by the Vanado-molybdo-phosphoric yellow colour method (Jackson, 1973), while total K was calculated by Flame Photometry (Jackson, 1973).

3.8.2. N, P, K uptake by the parasite

The product of the content of N, P, K and the respective dry weights (biomass) will give the nutrient uptake and expressed as gm per tree.

3.8.3. Carbohydrate uptake by the parasite

Carbohydrate content in the parasite was estimated by iodimetry. The product of the carbohydrate content and respective dry weight will give the uptake of carbohydrate by the parasite.

3.8.4. Protein uptake by the parasite

Crude protein was estimated by multiplying N content by the factor 6.25 (Simpson <u>et</u> <u>al</u>, 1965). Uptake of protein was calculated by multiplying the protein content with the respective dry weight.

3.9. Residual toxicity in mango fruits

Residual content of the effective chemical, atrazine in subsequent fruits was estimated by using U.V. Spectrophotometry. Residual content of glyphosate in the fruits was not detected since no fruits were produced on the trees.

3.10. Economics of Operation

Comparative evaluation of the cost of two methods viz. cultural control and chemical control was calculated to find out the economic feasibility of the control measures.

3.11. Statistical analysis

Data relating to the different parameters were subjected to analysis of variance and analysis of covariance by applying transformations, wherever necessary. Correlation between number of infestations, number of haustoria spread of infestation biomass of the parasite, N, P and K uptake, corbohydrate uptake and protein uptake were also estimated.

RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

An investigation was conducted at College of Agriculture, Vellayani to study the phanerogamic parasite infestation in mango tree and to suggest its control measures. The results obtained from the survey conducted at four Agricultural Farms of South Kerala are furnished below. In the field experiments also observations were made on the host and the parasite on various aspects. The data recorded were analysed statistically and the results are given below.

4.1. Survey

Table 4.1. Age Status of mango trees in different Agricultural Farms

Name of the farm	Year of planting	Age group of trees
Instructional Farm, College of Agriculture, Vellayani. (Thiruvananthapuram District)	1964-1965	28-29
District Agricultural Farm, Peringamala. (Thiruvananthapuram District)	1964	29
District Agriculutural Farm, Anchal.(Kollam District)	1974-'75-'76	17-19
District Agriculutural Farm, Mavellikkara. (Alapuzha District)	1964-'65-'66	27-29

The age of mango trees in different Agricultural Farms of Southern Kerala are presented in Table 1. The mango orchards of District Agricultural Farms at Peringamala, Mavelikkara and the Instructional Farm, at College of Agriculture, Vellayani were of 27 to 29 years old. But the mango orchard at District Agricultural Farm, Anchal, was relatively younger and was less than 20 years old.

The data on Loranthus infestation on different varieties of mango trees and the intensity of infestation at the Instructional Farm, attached to the College of Agriculture, Vellayani is presented in Table 4.2.

A persual of the data indicated that the mango variety Bangalora was the least infested with the parasite (40%) while all other varieties surveyed were severely attacked by the parasite to an average of 75 to 100 per cent.

It was also noticed that in Bangalora variety only 20 percent of the branches were attacked by the parasite as compared to 64 to 100 per cent infestation in other varieties.

The minimum occurrence and less intensity of Loranthus infestation on the variety Bangalora indicates its tolerance to the parasite attack in Vellayani.

Table 4.2. Rate of occurrence of Loranthus on mango varieties and their intensity of occurrence in individual trees at Instructional Farm, College of Agriculture, Vellayani

Name of the variety	Rate of occurrence of Loranthus in mango varieties					Intensity of occurrence on individual trees		
	Total no. of trees		Trees infested with Loranthus		Percentage of occurrence	Mean Number of branches	Number of branches infested	Percentage intensity
	Sample	Population	Sample	Population				
Chandrakaran	1	1	1	1	100	15	14	93
Bangalora	10	10	4	10	40	5	1	20
Vazhapazhuthi	1	1	1	1	100	10	10	100
Jehangir	1	1	1	1	100	15	14	93
Neelamundappa	10	11	10	11	100	4	3	75
Banganappalli	1	1	1	1	100	7	7	100
Neelum	3	3	3	3	100	7	7	100
Alphonso	4	4	4	4	100	6	5	83
Mulgoa	10	15	10	15	100	11	7	64
Kurukkan	6	6	6	6	100	9	7	78
Priyoor	2	2	2	2	100	10	8	80
Olour	4	4	4	3	75	8	6	75

The rate of occurrence and intensity of infestation of the parasite at District Agricultural Farm, Peringamala is given in Table 4.3. It could be noticed from the table that Olour, Priyoor, Rumania, Khudhadhatha and Mulgoa were free from the parasite infestation whereas the infestation in Nadusala and Bangalora recorded 13 and 14 per cent respectively. In Rajamanu, Mundappa, Chinnarasam, Alampur Baneshan, Peter, Solar summer and Kalappodi, the Loranthus infestation was below 25 per cent. All other varieties were severely infected with the parasite ranging from 60 to 90 per cent.

It was also observed that in Bangalora only 14 percent of the branches were infested with the parasite. Alampur Baneshan, Chinnarasam, Mundappa, Solar Summer, Rajamanu Kalappady and Peter were infested at a rate of 16 to 25 per cent. In all other varieties, 40 to 90 per cent of the branches were parasitized by Loranthus.

Similar to Vellayani in this location also Bangalora variety showed comparatively low range of infestation from Loranthus. However, varieties Olour, Priyoor, Rumania, Khudadatha and Mulgoa were free from Loranthus infestation.

Data pertaining to Anchal District Agricultural Farm on the infestation of Loranthus on mango orchard

Table 4.3. Rate of occurrence of Loranthus on mango varieties and their intensity of occurrence in individual trees at District Agricultural Farm, Peringamala

Name of the variety	Rate of occurrence of Loranthus in mango varieties					Intensity of occurrence on individual trees		
	Total no. of trees		Trees infested with Loranthus		Percentage of occurrence	Mean Number of branches	Number of branches infested	Percentage intensity
	Sample	Population	Sample	Population				
Neelum	10	52	10	52	100	8	5	63
Peter	10	50	1	5	10	5	1	20
Bangalora	10	51	1	5	10	7	1	14
Kalappadi	10	55	1	6	10	4	1	25
Rajumanu	10	50	3	15	30	6	1	17
Solar Summer	10	53	2	11	20	5	1	20
Himam Pasandh	10	50	8	40	80	6	4	67
Jehangir	10	54	8	43	80	5	3	60
Dasangiri	10	50	6	30	60	6	5	83
Banganapally	10	50	8	40	80	5	2	40
Maharaja Pasandh	10	51	1	5	10	3	2	67
Olour	10	34	0	0	0	8	0	0
Mundappa	6	25	3	13	50	6	1	17
Priyoor	4	28	0	0	0	4	0	0
Chinnarasam	9	50	5	28	56	6	1	17
Rumani	5	17	0	0	0	5	0	0
Nadusala	10	50	1	5	10	8	1	13
Khudadhatha	7	10	0	0	0	5	0	0
Mulgoa	10	51	9	46	90	6	3	50
Alampur Baneshan	10	16	3	5	30	6	1	17
Alphonso	6	6	4	4	67	6	5	83
Chandrakaran	10	10	9	9	90	10	9	90

revealed that all the varieties except Neelum were free from the attack. (Table 4.4). Even in Neelum the attack was confined to ten percent of the trees alone. In Neelum about 13 per cent of the branches were attacked with the parasite. This reduced infestation of Loranthus in mango trees may be attributed to the young stage of the orchard. The Anchal orchard was the youngest one among the orchards surveyed. (Table 4.1). Number of infested trees as well as mean number of clumps on individual trees increase with the age of orchards. Similar observations were reported by Ghosh etal (1984).

Table 4.5 reveals the data regarding Loranthus infestation on various mango varieties and the intensity of occurrence of the parasite, obtained from District Agricultural Farm, Mavelikkara.

From the table, it could be observed that Bangalora variety had an infestation of Loranthus to the tune of 20 per cent while Alphonso and Mulgoa recorded the maximum parasite occurrence (90%). The other varieties registered an infestation ranging from 40 to 70 per cent.

It could also be observed that Bangalora and Jehangir had only 40 per cent of their branches being parasitized by Loranthus. Eventhough the percentage of occurrence of parasite infestation was of 20 per cent in

Table 4.4. Rate of occurrence of Loranthus on mango varieties and their intensity of occurrence in individual trees at District Agricultural Farm, Anchal

Name of the variety	Rate of occurrence of Loranthus in mango varieties			Intensity of occurrence on individual trees	
	Total no. of trees		Trees infested with parasite	Mean number of branches	Mean number of infested branches
	Sample	Population	Sample		
Akkarappally	5	5	–	7	–
Banganappally	10	18	–	8	–
Allampur Baneshan	8	8	–	9	–
Bangalora	10	27	–	5	–
Bombay pairi	5	5	–	4	–
Chinnarasam	5	5	–	8	–
Chandanam	10	10	–	8	–
Mundappa	10	48	–	6	–
Priyoor	10	30	–	7	–
Himam Pasandh	10	10	–	6	–
Himayuddin	4	4	–	5	–
Kalappady	10	14	–	6	–
Pairi	10	15	–	7	–
Sindhuram	5	5	–	8	–
Suvarnarekha	10	15	–	8	–
Jahangir	10	15	–	10	–
Peter	5	5	–	7	–
Karpuram	6	6	–	8	–
Rajumanu	5	5	–	5	–
Kalkandom	5	5	–	6	–
Khudadhatha	5	5	–	7	–
Neelum	10	128	1	8	1
Alphonso	8	8	–	6	–
Baneshan	10	57	–	7	–
Mulgoa	3	3	–	5	–
Bennet Alphonso	5	5	–	5	–

Table 4.5. Rate of occurrence of Loranthus on mango varieties and their intensity of occurrence in individual trees at District Agricultural Farm, Mavelikkara

Name of the variety	Rate of occurrence of Loranthus in mango varieties: Total no. of trees		Trees infested with Loranthus		Percentage of occurrence	Intensity of occurrence on individual trees: Mean Number of branches	Number of branches infested	Percentage intensity
	Sample	Population	Sample	Population				
Neelum	10	140	6	84	60	9	5	55
Jehangir	10	30	7	21	70	5	2	40
Alphonso	10	40	9	36	90	6	3	50
Mulgoa	10	45	9	41	90	7	3	43
Bangalora	10	200	2	40	20	5	2	40
Pacharasi	10	20	4	8	40	9	6	67
Ammini	10	20	5	10	50	10	5	50
Vellakulampu	10	25	4	10	40	9	5	55
Suvarnarekha	10	25	6	15	60	8	5	63

Pacharasi, the intensity of infestation in branches recorded the maximum of 67 per cent. All other varieties ranged from 43 to 63 per cent. In this location also Bangalora variety showed a comparative tolerance to the attack of the parasite.

Table 4.6. depicts a general review of the survey. It could be observed that highest occurrence of Loranthus was in Instructional Farm, College of Agriculuture, Vellayani (88.63). The least infestation was noticed at District Agricultural Farm, Anchal. District Agricultural Farms of Mavelikkara and Peringamala registered an infestation of 48.6 and 42 per cent respectively. As stated earlier, the Anchal orchard is the youngest of the group while others come under the age group of 27 to 29 years. The higher percentage of infested trees in the older plantations of those areas might be due to the increased rate of birds frequenting the older trees with bigger canopy were more than in younger ones. This observation is in confirmity with the findings of Ghosh et al (1984). Moreover these farms were located in open country-side away from towns and cities. The orchards were free from the effects of harmful ecological problems of urbanization like pollution etc. This might have contributed to the uninhibited growth of the parasite. Similar observations were made by Hawksworth (1983).

From the observations taken, a score chart was prepared based on the range of Loranthus infestation on

Table 4.6. Location wise occurrence of Loranthus

Name of farm	Total no. of mango trees	Total no. of infested trees	Percentage of occurrence
District Agriculutural Farm, Mavelikkara.	545	265	48.6
District Agriculutural Farm, Anchal.	466	13	2.79
District Agriculutural Farm, Peringamala.	863	362	42.00
Instructional Farm, Vellayanai	53	47	88.68

Table 4.7. Range of infestation of Loranthus in different mango varieties

Range	Vellayani	Peringamala	Anchal	Mavelikkara
0%	Nil	Olour, Priyoor, Rumania, Khudhadhata	All varieties except Neelum	Nil
1-25%	Nil	Peter, Bangalora, Kalappady, Solar summer, Maharaja Pasanth, Nadusala.	All varieties identified in the farm.	Bangalora
26-50%	Bangalora	Rajamanu, Mundappa Alampur Baneshan,	Nil	Pacharasi, Vellakulampu. Ammini.
51-75%	Olour	Dasanagiri Chinnarasam Alphonso	Nil	Neelum, Jehangir, Suvarnarekha.
> 75%	Chandrakaran, Vazhapazhuthi, Jehangir, Neelamundappa, Benganappally, Neelum, Alphonso, Mulgoa, Kurukkan, Priyoor	Imam pasandh, Jehangir, Benganappally, Mulgoa, Chandrakaran, Neelum.	Nil	Alphonso, Mulgoa.

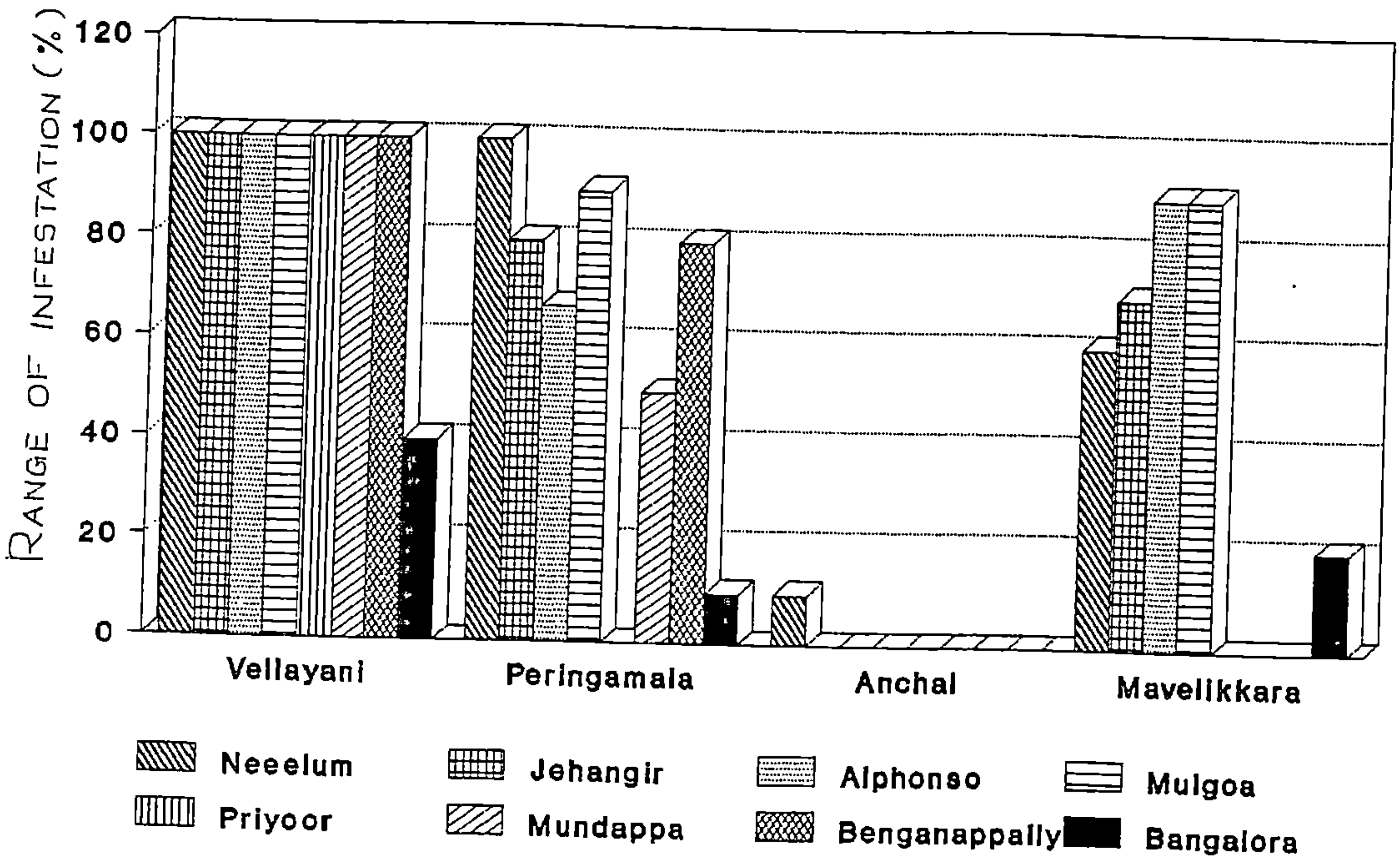

Fig. 4. Loranthus infestation (%) in common varieties of mango at different orchards of Southern Kerala

different varieties of mango and is given in Table 4.7 and Fig. 4.

From the chart it could be clearly observed that mango variety Bangalora is comparatively tolerant to Loranthus infestation, while Alphonso and Mulgoa varieties tend to be highly susceptible in three out of the four locations surveyed. Since other varieties were not common in all the four locations, a comparison was difficult to be made.

4.2. Cultural Method of Control

4.2.1. Observation on the parasite

4.2.1.1. Number of Infestation per tree

The number of infestations per tree as influenced by the cultural treatments are shown in Table 4.8.

The cultural treatments exerted a significant influence on the number of parasites on the host tree at three and six months after the administration of it. Number of infestation was low when the treatment was given at an interval of three months (T_1) as compared to six months (T_2) interval. The reduced number of infestations in case of T_1 as compared to T_2 might be attributed to the increased frequency between the removal of the parasite. Since the

Table 4.8. Effect of cultural treatments on the number of host branches infested, number of infestation per tree, number of haustoria in each infestation and spread of each infestation

Treat-ments	Number of host branches infested by the parasite		Number of infestations per tree		Number of haustoria in each infestation		Spread of each infestation	
	Three MAT	Six MAT	Three MAT	Six MAT	Three MAT	Six MAT	Three MAT	Six MAT
T_1	3.13 (1.77)	3.63 (1.91)	3.94 (1.99)	5.37 (2.32)	1.00 (1.00)	1.64 (1.28)	3.72 (1.93)	2.36 (1.54)
T_2	6.06 (2.46)	6.44 (2.54)	8.94 (2.99)	14.73 (3.84)	1.30 (1.14)	2.31 (1.52)	3.90 (1.97)	3.58 (1.89)
T_3	4.41 (2.10)	4.41 (2.10)	6.72 (2.59)	6.72 (2.59)	8.23 (2.87)	8.24 (2.87)	46.68 (6.83)	47.32 (6.88)
SE m ±	0.15	0.13	0.34	0.36	0.11	0.10	0.21	0.22
CD	0.47	0.40	NS	1.12	0.34	0.33	0.67	0.68

T_1 - Clearing of the parasite once in three months

T_2 - Clearing of the parasite once in six months

T_3 - Unweeded control

MAT - Months after treatment

Figures given in parenthesis are transformed values and comparisons are made based on them.

interval between two clearings was short, the parasite might not have obtained a chance for a prolific regrowth in case of T_1.

The number of infestation per tree was increased to 36 and 65 percent in case of T_1 and T_2 respectively. This clearly reveals the virulent occurrence of the parasite by resprout from the remnants of haustoria embedded in the host cells. Similar observations in Loranthus were noticed by Johri et al (1972).

It might also be noted that the experimental period coincided with the flowering and fruiting seasons of the parasite. This might also have contributed to the increased number of infestations. The observation is in confirmity with the findings of Balasundaran and Ghosh (1986).

Agrios (1969) reported that the only means of controlling mistletoe is by physical removal of the parasite. However, the results of the present study indicate that a control will be obtained only by the frequent removal of the parasite.

4.2.1.2. Number of Haustoria in Each Infestation

Mean values of number of haustoria in each infestation as influenced by the cultural treatments are given in Table 4.8.

The treatments had a profound effect on the number of haustoria in each infestation. Clearing of the parasite once in three months (T_1) and once in six months (T_2), recorded a sharp decline in the number of haustoria. This reduced number of haustoria in T_1 and T_2 might be due to the lesser time gap available for development of the parasite.

4.2.1.3. Spread of Each Infestation

The results regarding the effect of cultural treatments on the spread of each infestation are summarised in Table 4.8.

Spread of infestation was significantly reduced in case of trees in which the parasite removal was done once in three months (T_1) and once six months (T_2) and were comparable with each other. The reduction in the spread of infestation was 8 and 37 per cent respectively in T_2 and T_1. This reduction in spread of infestation in case of trees in which the parasite removal was done either in three or six months interval might be due to the less branching of the parasite. The reduced number of infestations and haustoria might also have contributed to the reduced spread of infestation.

Spread of infestation was positively correlated with the number of haustoria in each infestation as seen in Table 4.16.

4.2.1.4. Biomass of the Parasite

The effect of various treatments on the biomass of the parasite as observed at third and six months after the administration of the treatments are presented in Table 4.9.

The biomass of the parasite was significantly influenced by the cultural treatment and the least quantity was recorded in the treatment where the removal of the parasite was done in three months (T_1) than T_2, (removal of parasite once in six months). This reduction in biomass of parasite might be due to the lesser number of infestation, less number of haustoria and reduced spread of infestation. The biomass of the parasite recorded a low value in T_1 due to frequent clearings and remained static. But in T_2 are increased biomass production was noticed which was to the tune of 51 per cent between the period of third to six months after the treatment. By the frequent removal of the profuse vegetative growth, the rejuvenation of the parasite was very much reduced, which might have decreased the total biomass in T_1.

Table 4.9. Effect of cultural treatments on biomass of the parasite, and N, P, K uptake of the parasite

Treatments	Biomass of the parasite (kg/tree)		Nitrogen uptake by the parasite (g/tree)		Phosphours uptake by the parasite (g/tree)		Potash uptake by the parasite (g/tree)	
	Three MAT	Six MAT	Three MAT	Six MAT	Three MAT	Six MAT	Three MAT	Six MAT
T_1	0.37 (0.60)	0.38 (0.61)	3.98 (2.00)	3.73 (1.93)	0.98 (0.99)	1.00 (1.00)	5.27 (2.30)	5.40 (2.33)
T_2	0.74 (0.86)	1.12 (1.06)	5.53 (2.35)	8.38 (2.89)	1.82 (1.35)	2.78 (1.67)	10.33 (3.21)	15.51 (3.94)
T_3	2.76 (1.66)	2.76 (1.66)	25.76 (5.08)	25.76 (5.08)	11.08 (3.33)	11.08 (3.33)	35.58 (5.97)	35.58 (5.97)
SE m ±	0.15	0.14	0.50	0.48	0.31	0.31	0.52	0.50
CD Treatments	0.47	0.45	1.58	1.51	0.98	0.97	1.64	1.59

T_1 - Clearing of the parasite once in three months

T_2 - Clearing of the parasite once in six months

T_3 - Unweeded control

MAT - Months after treatment

Figures given in parenthesis are transformded values and comparisons are made based on them

Biomass of the parasite was found to have a positive correlation with the number of infestations, number of haustoria and spread of each infestation. (Table 4.16).

Hawksworth (1978) reported that the slow rate of spread is a characteristic feature that makes dwarf mistletoes amenable to sivicultural control.

4.2.2. <u>Observation on the Host (Mango Tree)</u>

4.2.2.1. Number of Branches Infested by the Parasite

Data related to the influence of treatments on the number of branches infested by the parasite are given in the Table 4.8.

The cultural treatments showed a comparable influence of the parasite on the number of infested branches of the host at three and six months after the treatment. When observed after six months, an increase of 16 per cent and 6 per cent in the number of infested branches was observed in T_1 (clearing of parasite once in three months) and T_2 (clearing of the parasite once in six months) respectively. This increase might be due to the quick regeneration capacity of the haustoria embedded in the host plant. However the control treatment showed a stagnation in the number of branches when observed after three and six months.

Removal of the parasite is a common practice of control among the farmers. However the present study reveals that a quick re-establishment is occurring in the host tree. Hence any other suitable measure to control the haustoria alone will check the spread of infestation.

4.2.3. <u>Chemical Analysis</u>

4.2.3.1. Nitrogen (N), Phosphorous (P) and Potash (K) Uptake by Parasite

Table 4.9 gives the effect of treatments on N,P,K uptake by the parasite.

The uptake of N,P,K was profoundly influenced by the cultural treatments. The N and P uptake by the parasite was appreciably low in the treatments which eliminated the parasite once in three (T_1) or six months(T_2)as compared to control, and they were onapar with each other. The K uptake showed comparable results for T_1 and T_2 at three months after treatment. However, at six months after the treatment, T_2 recorded a higher uptake value than T_1. The increased uptake of nutrients in control treatment might be due to the undisturbed growth of the parasite as compared to other treatments. Significant reduction in N,P,K uptake in T_1 and T_2 could be attributed to the reduced number of haustoria and biomass of the parasite. The newly emerged haustoria might have been ineffective in absorbing the nutrients.

Correlation studies also revealed a positive correlation between N,P,K uptake, number of haustoria and the biomass of the parasite (Table 4.16).

Onofeghara (1981) found that mistletoes act as sink for photosynthetic products of the hosts and depend entirely on the hosts for water and mineral nutrients.

Glatzel (1983) reported that mistletoes greatly store potassium.

4.2.3.2. Carbohydrate Uptake by the Parasite

The effect of treatments on carbohydrate uptake is given in table 4.10.

Carbohydrate uptake was less in trees in which the parasite was removed at three months (T_1) as compared to T_2 (removal of parasite once in six months) and control. In T_1, the number of haustoria in each infestation and the biomass of the parasite recorded a lower value which might have resulted in the low uptake of carbohydrate.

Carbohydrate uptake was found to be positively correlated with the number of haustoria in each infestation and the biomass of the parasite. (Table 4.16)

Table 4.10. Effect of cultural treatments on carbohydrate and protein uptake by the parasite

Treatments	Carbohydrate uptake by the parasite (g/tree)		Protein uptake by parasite (g/tree)	
	Three MAT	Six MAT	Three MAT	Six MAT
T_1	45.11 (6.72)	47.44 (6.83)	24.80 (4.98)	23.32 (4.83)
T_2	81.40 (9.02)	141.12 (11.88)	34.60 (5.88)	52.36 (7.24)
T_3	314.28 (17.73)	233.41 (15.28)	161.02 (12.69)	161.02 (12.69)
SE m ±	1.60	2.65	1.26	1.20
CD Treatments	5.05		3.96	3.77

T_1 - Clearing of the parasite once in three months

T_2 - Clearing of the parasite once in six months

T_3 - Unweeded control MAT - Months after treatment

Figures given in parenthesis are transformed values and comparisons are made based on them

Aber et al (1983) suggested that sucrose could be the main metabolite involved in the transfer of organic substances from host plant to parasite.

4.2.3.3. Protein Uptake by the Parasite

Mean values of protein uptake by the parasite as influenced by various cultural treatments are presented in Table 4.10.

Table 4.16 reveals that the treatments significantly influenced the uptake of protein by the parasite. Trees in which the clearing of the parasite was carried out once in three months showed a reduced uptake and was found to be on a par with the trees in which clearing was done once in six months. Periodic removal of the parasite reduced the number of infestations, number of haustoria and the biomass of the parasite, which resulted in low uptake of protein.

Correlation studies also revealed a positive correlation between protein uptake, biomass of the parasite and the number of haustoria. (Table 4.16).

4.3. Chemical Method of Control

4.3.1. Observations on the Parasite

4.3.1.1. Number of Infestations Per Tree

The effect of herbicides, method of application and its interactions are given in Table 4.11.

It could be inferred from the table that the herbicides, the method of application and its interaction profoundly influenced the number of infestations of the parasite on the host plant at third and sixth month after the administration of treatments. Atrazine and glyphosate recorded the least number of infestations and were on a par with each other. Similar effects of atrazine and glyphosate were reported by Bayer, (1967) and Minko and Fagg (1989) in controlling the parasite on various host trees. Between the two methods of application, infusion of herbicides was superior to padding as seen in the observations recorded at three and six months after treatment of chemical. This might be due to the better absorption of herbicides by infusion than padding. Natarajan (1990) had reported the effectiveness of padding with monocrotophos in controlling woolly aphis in apple. However the results of the present study indicated that padding was not very effective in controlling tree parasite Loranthus.

Table 4.11. Effect of chemical treatments on number of infestations of the parasite per tree and number of haustoria in each infestation

	Number of infestations per tree						Number of haustoria in each infestation					
Treatments	Three MAT			Six MAT			Three MAT			Six MAT		
	m_1	m_2	Mean (C)	m_1	m_2	Mean (C)	m_1	m_2	Mean (C)	m_1	m_2	Mean (C)
C_1	14.29 (3.78)	11.97 (3.46)	13.10 (3.62)	14.29 (3.78)	11.97 (3.46)	13.10 (3.62)	5.02 (2.24)	4.71 (2.17)	4.88 (2.21)	5.02 (2.24)	4.71 (2.17)	4.88 (2.21)
C_2	13.25 (3.64)	2.82 (1.68)	7.08 (2.66)	13.25 (3.64)	2.82 (1.68)	7.08 (2.66)	4.80 (2.19)	4.28 (2.07)	4.54 (2.13)	4.80 (2.19)	4.28 (2.07)	4.54 (2.13)
C_3	12.39 (3.52)	2.62 (1.62)	6.60 (2.57)	12.39 (3.52)	2.62 (1.62)	6.60 (2.51)	4.97 (2.23)	2.13 (1.46)	3.42 (1.85)	4.97 (2.23)	2.13 (1.46)	3.42 (1.85)
C_4	13.40 (3.66)	12.53 (3.54)	12.96 (3.60)	13.40 (3.66)	12.53 (3.54)	12.96 (3.60)	4.93 (2.22)	3.96 (1.99)	4.45 (2.11)	4.93 (2.22)	3.96 (1.99)	4.45 (2.11)
Mean (M)	13.32 (3.65)	6.55 (2.56)		13.32 (3.65)	6.55 (2.56)		4.93 (2.22)	3.69 (1.92)		4.93 (2.22)	3.69 (1.92)	
Control (Mean)	12.74 (3.57)			12.74 (3.57)			5.11 (2.26)			5.11 (2.26)		
SE m ±	0.11			0.11			0.05			0.05		
CD (0.05) herbicides	0.34			0.34			0.16			0.16		
SE m ±	0.14			0.14			0.08			0.08		
CD methods	0.43			0.43			0.24			0.24		
SE m ±	0.15			0.15			0.07			0.07		
CD interaction	0.45			0.45			0.20			0.20		

C_1 - Simazine C_2 - Atrazine C_3 - Glyphosate C_4 - Dalpon

m_1 - Padding m_2 - Infusion MAT - Months after treatment.

Figures given in parentheses are transformed values and comparisons are made based on them.

The interaction effects of herbicides and the method of application revealed the superiority of atrazine (C_2) and glyphosate (C_3) by infusion.

4.3.1.2. Mean Number of Haustoria in each Infestation

Table 4.8 represents the influence of herbicides, method of application and its interactions, on the number of haustoria in each infestation.

Mean number of haustoria in each infestation was significantly influenced by the herbicides, methods of application and their interaction.

Among the herbicides, glyphosate appreciably controlled the number of haustoria in the parasite infestation at both three and six months after the application of herbicides. Infusion of chemicals was found to be more effective than padding. The better translocation of herbicides might have resulted in the drying of large portion of the haustoria in individual infestations. The newly emerged parasite showed only a minimum number of haustoria.

Singh (1962) noticed that a large number of haustoria of D. falcata, in different trees absorb a large quantity of nutrients from its host resulting in growth retardation.

The interaction effect of herbicides and methods of application recorded the superiority of infusion of glyphosate as compared with all other treatments.

4.3.1.3. Spread of Infestation

The mean spread of infestation as influenced by the herbicides, methods application and its interactions are presented in Table 4.9.

Spread of each infestation was significantly checked by the herbicides, methods of application and their interactions.

Atrazine and glyphosate registered least spread of infestation at third and sixth month after the application. Infusion of herbicides registered lesser spread as compared to padding. Among the interactions, infusion of atrazine was better in checking the spread followed by infusion of glyphosate. All other treatments were on a par with the control.

A better check in the spreading of infestation of parasite in trees infused with atrazine and glyphosate could be attributed to the less branching of the parasite in these two treatments. An appreciable reduction in the number of infestations and haustoria might also have a favourable influence on the reduced spread of the parasite.

Table 4.12. Effect of chemical treatments on spread of each infestation of the parasite and the biomass of the parasite

Treatments	Spread of each infestation (cm) Three MAT m_1	Three MAT m_2	Three MAT Mean (C)	Six MAT m_1	Six MAT m_2	Six MAT Mean	Biomass of the parasite (Kg/tree) Three MAT m_1	Three MAT m_2	Three MAT Mean	Six MAT m_1	Six MAT m_2	Six MAT Mean
C_1	25.81 (5.08)	27.14 (5.21)	26.52 (5.15)	25.81 (5.08)	27.14 (5.21)	26.52 (5.15)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)
C_2	25.60 (5.06)	16.81 (4.10)	20.98 (4.58)	25.60 (5.06)	16.40 (4.05)	20.70 (4.55)	3.50 (1.87)	1.39 (1.18)	2.34 (1.53)	3.50 (1.87)	1.39 (1.18)	2.34 (1.53)
C_3	24.30 (4.93)	10.63 (3.26)	16.81 (4.10)	24.30 (4.93)	10.76 (3.28)	16.89 (4.11)	3.50 (1.87)	1.32 (1.15)	2.28 (1.51)	3.50 (1.87)	1.32 (1.15)	2.28 (1.51)
C_4	28.09 (5.30)	26.83 (5.18)	27.46 (5.24)	27.88 (5.28)	27.04 (5.20)	27.46 (5.24)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)	3.50 (1.87)
Mean (M)	25.91 (5.09)	19.71 (4.44)		25.91 (5.09)	19.71 (4.44)		3.50 (1.87)	2.31 (1.52)		3.50 (1.87)	2.31 (1.52)	
Control (Mean)	28.41 (5.33)			28.41 (5.33)			8.53 (1.88)			3.50 (1.87)		
SE m ±	0.16			0.16			0.04			0.04		
CD herbicides	0.48			0.48			0.13			0.13		
SE m ±	0.27			0.27			0.05			0.05		
CD methods	0.80			0.80			0.15			0.15		
SE m ±	0.21			0.21			0.05			0.05		
CD interaction	0.62			0.62			0.14			0.14		

C_1 - Simazine C_2 - Atrazine C_3 - Glyphosate C_4 - Dalapon

m_1 - Padding m_2 - Infusion MAT - Months after treatment.

Figures given in parenthesis are transformed values and comparisons are made based on them

4.3.1.4. Biomass of the Parasite

Biomass of the parasite was recorded at three and six months after the treatment and the mean values are given in Table 4.9.

Table 4.9 revealed that the herbicides, methods of application and their interactions significantly affected the biomass of the parasite. Atrazine and glyphosate considerably reduced the biomass of the parasite and was on a par with each other at both the intervals of observation Ravindran (1976), Balu and Sankaran (1977), Ali and Sankaran (1985), have also reported similar reduction in dry weight of weeds by the use of herbicides.

Infusion was found to be superior to padding in controlling the biomass of the parasite at both the intervals of observations.

Among the interactions, infusion of atrazine or glyphosate were found to be comparable to each other in checking the biomass of the parasite and was superior to other treatment combinations. All other treatments accounted a higher biomass yield of the parasite. This increase in biomass yield might be due to the uninhibited absorption of nutrients from the host.

Correlation studies have revealed that a positive and significant correlation existed between biomass and the number of parasite infestations (Table 4.16). The reduced parasite infestations might also have influenced in the redution of biomass of the parasite.

4.3.2. Observations on the Host (Mango Tree)

4.3.2.1. Girth of Branch

The effect of herbicides and their methods of application on the girth of host plant is presented in Table 4.13.

From the Table it can be seen that neither the chemicals nor the method of its application had influenced the girth of host branches. The insignificant effects of the treatments might be due to the short time gap between the administration of the treatment and the observation.

4.3.2.2. Visual symptoms of toxicity

No symptoms of herbicidal toxicity was observed in any of the host plants treated with the chemicals.

Table 4.13. Effect of chemical treatments on the girth of host branch (cm)

Treatments	Three MAT			Six MAT		
	m_1	m_2	Mean (C)	m_1	m_2	Mean (C)
C_1	30.82	30.66	30.74	30.79	30.66	30.73
C_2	30.71	31.03	30.87	30.69	31.01	30.85
C_3	30.71	30.79	30.75	30.69	30.78	30.74
C_4	30.70	30.66	30.68	30.70	30.67	30.69
Mean (M)	30.74	30.79		30.72	30.78	
Control mean	30.71			30.69		
SE m ±	0.12			0.11		
CD (0.05)	0.35			0.34		

C_1 - Simazine

C_2 - Atrazine

C_3 - Glyphosate

C_4 - Dalapon

m_1 - Padding

m_2 - Infusion

MAT - Months after treatment.

4.3.3. Chemical Analysis of the Parasite

4.3.3.1. Nitrogen (N), Phosphorous(P), Potash (K) uptake by the parasite

The data on the uptake at N,P,K by the parasite at three and six months after the administration of the treatments are presented in Table 4.14.

From the Table it is clear that the influence of herbicides, methods of application and its interactions on N,P and K uptake by the parasite were more or less of the same pattern and hence they are referred together as "Nutrient uptake".

The absorption of nutrients by the parasite was significantly influenced by the treatments and their interactions. Atrazine and glyphosate were found to be effective in checking the absorption of nutrients by the parasite. Between the methods of application, infusion technique effectively checked the absorption of nutrients by the parasite. Atrazine and glyphosate applied as infusion registered a low value of nutrient uptake than other herbicides or by padding. This reduced uptake might be attributed to the reduced biomass and lesser number of the parasite infestations. The young haustoria developed after the rejuvenation might be inefficient in absorbing the nutrients and resulted in reduced uptake rate in these

Table 4.14. Effect of chemical treatments on NP uptake by the parasite

Treatments	(a) Nitrogen uptake by the parasite (g/tree) Three MAT m_1	m_2	Mean (C)	Six MAT m_1	m_2	Mean (C)	(b) Phosphorous uptake by the parasite (g/tree) Three MAT m_1	m_2	Mean (C)	Six MAT m_1	m_2	Mean (C)
C_1	27.35 (5.23)	27.46 (5.24)	27.46 (5.23)	27.35 (5.23)	27.46 (5.24)	27.46 (5.24)	7.95 (2.82)	7.95 (2.82)	7.95 (2.82)	7.95 (2.82)	7.95 (2.82)	7.95 (2.82)
C_2	27.67 (5.26)	10.43 (3.23)	18.06 (4.25)	27.67 (5.26)	10.43 (3.23)	18.06 (4.25)	7.67 (2.77)	2.96 (1.72)	5.06 (2.25)	7.67 (2.77)	2.96 (1.72)	5.06 (2.25)
C_3	27.46 (5.24)	11.76 (3.43)	18.83 (4.34)	27.46 (5.24)	11.46 (3.43)	18.83 (4.34)	7.84 (2.80)	1.96 (1.74)	5.15 (2.27)	7.84 (2.80)	1.96 (1.74)	5.15 (2.27)
C_4	27.56 (5.25)	27.46 (5.24)	27.56 (5.25)	27.56 (5.25)	27.46 (5.24)	27.56 (5.25)	7.84 (2.80)	7.90 (2.81)	7.90 (2.81)	7.84 (2.80)	7.90 (2.81)	7.90 (2.81)
Mean (M)	27.56 (5.25)	18.40 (4.29)		27.56 (5.25)	18.40 (4.29)		7.84 (2.80)	4.58 (2.14)		7.84 (2.80)	4.58 (2.14)	
Control (Mean)	27.67 (5.26)			27.67 (5.26)			7.29 (2.78)			7.29 (2.78)		
SE m ±	0.13			0.13			0.08			0.08		
CD herbicides	0.38			0.38			0.24			0.24		
SE m ±	0.13			0.13			0.09			0.09		
CD methods	0.39			0.39			0.28			0.28		
SE m ±	0.14			0.14			0.09			0.09		
CD interaction	0.41			0.41			0.27			0.27		

C_1 - Simazine C_2 - Atrazine C_3 - Glyphosate C_4 - Dalapon

m_1 - Padding m_2 - Infusion MAT - Months after treatment.

Figures given in parenthesis are transformed values and comparisons are made based on them

Contd...

(Contd...)

Table 4.14. Potassium uptake by the parasite (gms/tree)

Treatments	Three MAT m_1	m_2	Mean (C)	Six MAT m_1	m_2	Mean (C)
C_1	48.44 (6.96)	49.28 (7.02)	48.86 (6.99)	48.16 (6.94)	49.28 (7.02)	48.72 (6.98)
C_2	46.79 (6.84)	19.27 (4.39)	31.58 (5.62)	46.79 (6.84)	19.27 (4.39)	32.26 (5.68)
C_3	47.89 (6.92)	19.18 (4.38)	31.92 (5.65)	47.89 (6.92)	19.18 (4.38)	31.92 (5.65)
C_4	48.16 (6.94)	50.55 (7.11)	49.42 (7.03)	48.16 (6.94)	50.55 (7.11)	49.42 (7.03)
Mean (M)	47.89 (6.92)	32.83 (5.73)		47.75 (6.71)	32.83 (5.73)	

	Three MAT	Six MAT
Control mean	46.38 (6.81)	46.38 (6.81)
SE m $\pm$	0.21	0.21
CD herbicides	0.64	0.64
SE m $\pm$	0.28	0.28
CD methods	0.84	0.84
SE m $\pm$	0.24	0.24
CD interactions	0.72	0.73

C_1 - Simazine C_2 - Atrazine C_3 - Glyphosate C_4 - Dalapon

m_1 - Padding m_2 - Infusion MAT - Months after treatment

Figures given in parenthesis are transformed values and comparisons are made based on them

Correlation studies also have revealed that a positive correlation existed between the biomass and carbohydrate uptake of the parasite. (Table 4.16)

4.3.3.3. Protein Uptake by the Parasite

The data on the uptake of protein by the parasite as influenced by the treatments and its interactions are presented in the Table 4.15.

Protein uptake by the parasite was appreciably influenced by the herbicides method of application and their interactions. The least value of protein uptake was obtained when the trees were treated with atrazine or glyphosate. Similarly infusion also reduced the protein uptake of the parasite as compared to padding. Among the interactions, infusion of atrazine and glyphosate, significantly reduced the protein uptake of the parasite.

The reduced uptake of protein by the parasite in trees infused with atrazine and glyphosate could be attributed to the reduced number of infestations, lesser biomass of the parasite.

Protein uptake by the parasite was positively correlated with its biomass (Table 4.16).

Table 4.15. Effect of chemical treatments on carbohydrate and protein uptake by the parasite

Treatments	Carbohydrate uptake by the parasie (g/trees) Three MAT m_1	m_2	Mean (C)	Six MAT m_1	m_2	Mean (C)	Protein uptake by the parasite (g/trees) Three MAT m_1	m_2	Mean (C)	Six MAT m_1	m_2	Mean (C)
C_1	400.00 (20.00)	398.40 (19.96)	399.20 (19.98)	400 (20.00)	398.46 (19.96)	399.20 (19.98)	171.35 (13.09)	171.87 (13.11)	171.61 (13.10)	171.35 (13.09)	171.87 (13.11)	171.64 (13.10)
C_2	393.23 (19.83)	163.07 (12.77)	265.69 (16.30)	393.23 (19.83)	163.07 (12.77)	265.69 (16.30)	172.92 (13.15)	65.29 (8.08)	112.78 (10.62)	172.92 (13.15)	65.29 (8.08)	112.78 (10.62)
C_3	397.60 (19.94)	156.50 (12.51)	263.41 (16.23)	397.60 (19.94)	156.50 (12.51)	263.41 (16.23)	171.87 (13.11)	72.93 (8.54)	117.29 (10.83)	171.87 (13.11)	72.93 (8.54)	117.29 (10.83)
C_4	396.01 (19.01)	399.60 (19.99)	398.00 (19.95)	396.01 (19.01)	399.60 (19.99)	398.00 (19.95)	172.40 (13.13)	171.61 (13.10)	172.13 (13.12)	172.40 (13.13)	171.61 (13.10)	172.13 (13.12)
Mean (M)	396.81 (19.92)	266.02 (16.31)		396.81 (19.92)	266.02 (16.31)		172.13 (13.12)	114.70 (10.70)		172.13 (13.12)	114.70 (10.70)	
Control (Mean)	392.04 (19.80)			394.42 (19.86)			172.92 (13.15)			172.93 (13.15)		
SE m ±	0.53			0.53			0.31			0.31		
CD herbicides	1.60			1.60			0.94			0.94		
SE m ±	0.57			0.57			0.33			0.33		
CD methods	1.72			1.72			0.98			0.98		
SE m ±	0.57			0.57			0.34			0.34		
CD interaction	1.72			1.72			1.02			1.02		

C_1 - Simazine C_2 - Atrazine C_3 - Glyphosate C_4 - Dalpon

m_1 - Padding m_2 - Infusion MAT - Months after treatment.

Figures given in parenthesis are transformed values and comparisons are made based on them

treatments. A positive correlation between the biomass and nutrient uptake was also observed. (Table 4.16). In phanerogamic parasites water and minerals were absorbed from the host plant and was reported by many workers [Kumar et al (1973), Onofeghara (1981) Rey et al (1991)]

4.3.3.2. Carbohydrate Uptake by the Parasite

The effect of herbicides, methods of application and its combinations are presented in Table 4.15.

It could be noticed from the table that the herbicides, methods of application and their interactions appreciably influenced the carbohydrate uptake of the parasite at three and six months after application.

Application of atrazine and glyphosate accounted a lower rate of carbohydrate uptake by the parasite. Of the two methods of application, infusion registered a lower uptake value for carbohydrate, as compared to padding. Among the combinations tried, infusion of atrazine or infusion of glyphosate recorded lesser uptake of carbohydrate by the parasite. Fer (1981) reported that in cuscuta carbohydrates were absorbed from host phloem. Johri and Bhatnagar (1972)observed that the outer zone of D. falcata consists of layers of tannin filled cells packed with starch.

Table 4.16. Correlation studies

	Spread of each infestation 3 MAT	Spread of each infestation 6 MAT	Biomass 3 MAT	Biomass 6 MAT
Number of infestation 3 MAT			0.62^{**} $\mathbf{0.49}^{**}$	
Number of infestation 6 MAT				0.65^{**} $\mathbf{0.52}^{**}$
Number of haustoria 3 MAT	0.77^{**} $\mathbf{0.99}^{**}$			
Number of haustoria 6 MAT		0.76^{**} $\mathbf{0.99}^{**}$		
N uptake 3 MAT			0.97^{**} $\mathbf{0.97}^{**}$	
N uptake 6 MAT				0.97^{**} $\mathbf{0.97}^{**}$
P uptake 3 MAT			0.81^{**} $\mathbf{0.95}^{**}$	
P uptake 6 MAT				0.81^{**} $\mathbf{0.94}^{**}$
K uptake 3 MAT			0.87^{**} $\mathbf{0.95}^{**}$	
K uptake 6 MAT				0.87^{**} $\mathbf{0.96}^{**}$
CHO uptake 3 MAT			0.99^{**} $\mathbf{0.99}^{**}$	
CHO uptake 6 MAT				0.99^{**} $\mathbf{0.87}^{**}$
Protein uptake 3 MAT			0.97^{**} $\mathbf{0.98}^{**}$	
Protein uptake 6 MAT				0.97^{**} $\mathbf{0.97}^{**}$

Bold letters - Chemical method ** - Significant at 5% level

4.3.3.4. Residual toxicity in subsequent fruits

Residual toxicity of mango fruits was studied for $c_2 m_2$, infusion of atrazine alone. The test was conducted six months after the application of herbicide. It was found that the concentration of herbicide in the fruit was below the maximum tolerance limit of 0.05 ppm. Hence infusion of atrazine can be safely recommended for controlling the parasite without any deleterious effect on the fruit quality. The observation tallies with that of Luckwill et al. (1966).

4.4. Economics of Operation

The economics of operation for cultural and chemical methods are given in Appendix II and III.

The best treatment combinations identified for the control of Loranthus were application of atrazine and glyphosate through infusion. The $c_2 m_2$ and $c_3 m_2$ treatments accounted Rs. 2647 per ha per year. Between the two methods of application, padding incurred a lesser cost than infusion. However looking in to the efficiency, infusion can be recommended over padding. The cultural control of Loranthus infestation recorded an amount of Rs. 5904 ha^{-1} yr^{-1} for T_1 and Rs. 2952 ha^{-1} yr^{-1} for T_2. By comparing the best treatments of cultural and chemical methods, it was observed that chemical treatments were more effective.

SUMMARY

SUMMARY

Field experiments were conducted at Instructional Farm attached to the College of Agriculture, Vellayani during 1992-1993 with an object to study the control measures of phanerogamic parasites viz., Loranthus infesting on mango tree. A survey work was also conducted in the mango orchards at four different locations viz., Instructional Farm, College of Agriculture, Vellayani, District Agricultural Farm (D.A.F.), Peringamala, District Agricultural Farm, Anchal, District Agricultural Farm, Mavelikkara of Southern Kerala to assess the spread of infestation of Loranthus.

The survey work conducted at four locations in South Kerala revealed that mango varieties were infested with only one species of Loranthus viz., _Helicanthes elastica_. It was noticed that older orchards had higher occurrence of these parasitic weed than young ones.

Among the four locations surveyed, the maximum infestation of Loranthus was noticed at Instructional Farm, College of Agriculture, Vellayani. The attack was noticed in 88.6 per cent of the trees. While D.A.F., Mavelikkara, D.A.F., Peringamala recorded the attack of Loranthus to 48.6 and 42 per cent trees respectively. The least infestation

was observed at D.A.F., Anchal (2.75 %). Out of the eight common and popular varieties cultivated in all the locations, Bangalora recorded the least occurrence of Loranthus.

Experiments were also conduted at Instructional Farm, College of Agriculture, Vellayani to study the effectiveness of the cultural method of control and chemical method of control of Loranthus in mango orchards. In cultural control, the treatments viz., removal of parasite once in three months (T_1) once in six months (T_2) and unweeded control (T_3) were tested in a Randomised Block Design (R.B.D.) with six replications. The chemical control experiment was conducted with the following treatments viz., simazine 10 mg a.i. per litre (C_1) atrazine 10 mg a.i. per litre (C_2) glyphosate 10 mg a.i. per litre (C_3) and dalapon 10 mg a.i. per litre (C_4) under two methods of application viz., Padding (M_1) and Infusion (M_2) in R.B.D. with three replications. An absolute control with no hericide application served as a common control treatment for comparison.

The frequent lopping of Loranthus as given by T_1 registered least number of infestation, and biomass as compared to T_2. In the ~~u~~unweeded control the biomass remained static during the period of observations. The number of haustoria, spread of infestation and nutrient uptake was comparable between T_1 and T_2. However, the flow of nutrients from the host was significantly higher in T_3 due to its heavier and undisturbed growth. Carbohydrate uptake was found to reduce considerably when the parasite removal was done once in three months, while both T_1 and T_2 were found to reduce the protein uptake of the parasite.

Among the herbicides tried, atrazine and glyphosate were found to reduce the number of infestations, spread of parasite infestation, biomass and nutrient uptake. Application of glyphosate considerably reduced the number of haustoria in each infestation. Infusion of herbicides into the host tree was found to be effective than padding. In short, as a conclusion it can be stated that infusion of atrazine or glyphosate significantly reduced the parasite infestation.

No symptoms of toxicity was observed on the host after application of the herbicides. Subsequent mango fruits also did not show a toxic amount of herbicide content in it.

Among the chemical treatments padding incurred lesser cost of application but considering the efficiency, infusion can be recommended over padding. Cultural treatments recorded a higher cost than chemical treatments.

Future line of work

1. An intensive survey on the occurrence and spread of the parasite may be initiated. Reasons for the wide spread occurrence like site quality, varietal variations, climate and other epidemological factors are to be analysed. Assessment of qualitative and quantitative losses caused by the parasite are to be worked out.

2. Efficiency of various herbicides in controlling the parasite is to be studied and suitable concentration of herbicidies to be standardized. A much elaborate study on the residual effect of the herbicides on the quality of fruits is to be carried out. A more sophisticated device for the infusion of herbicides is to be developed.

REFERENCES

REFERENCES

*
Aber, M., Fer, A. and Salle, G. 1983. Transfer of organic substance from the host plant Vicia faba to the parasite Orobanche crenata Forsk. Zeitschriff fur pflanzenphysiologie. 112 : pp. 297-308.

Agrios, G.N. 1969. Plant Pathology. Academic Press. Newyork. pp. 11: 390-394.

Alam, M.K. 1987. A critical review on the biology and control of Loranthaceae with a particular reference to Bangladesh Bano Bigyan Patrika. 13: pp. 7-18.

Ali, A.M. and Sankaran, S. 1985. Effect of pre-emergence herbicides on Echinochloa crusgelli (L) Beauv and Cyperus difformis L in transplanted rice Int. Rice Res. Newsl. 10: pp. 20

Ali, S. 1931. The role of sunbirds and flower peckers in the propagation and distribution of the tree parasite, Loranthus longiflorus Desr. in the Konkan. J. Bombay Nat. Hist. Soc. 35: pp. 144-149.

Bakshi, B.K. and Puri, Y.N. 1971. Dwarf mistletoe on blue pine in the Western Himalayas and its control Indian For. 97: pp. 547-552.

Balasundaran, M. 1984. Loranthus - a menace to trees - Evergreen. 13: pp. 20-22.

Balasundaran, M. and Ghosh, S.K. 1986. Mistletoe problem of trees in India. KFRI Scientific Paper No. 79. pp. 206-219.

Balasundaran, M. and Mohammed Ali, M.I. 1991. Mistletoe problem of teak and its control measures. Paper presented in the internatiaonal teak symposium.., Trivandrum 1991. Department of Forests, Kerala, India.

Balu, S. and Sankaran, S. 1977. Comparative efficiency of different herbicides for the control of weed in transplanted rice. In Proc. Weed Sci Conf., Indian Soc. of Weed Sci., College of Agriculture, Rajendra Nagar, A.P. India.

Bayer, D.E., Elmore, C.L., Chaney, D.H. and Buschmann, L.L. 1967. Control of mistletoe *Phoradendron flavescens*, on English Walnuts in California. Hort. Science. 2 : pp. 10-11.

Brandis, D. 1907. Indian trees. London Archibald Constable : pp. 767.

Brown, A.G. and Greenham, C.G. 1965. Further investigations in the control of mistletoe by trunk injections. Australian J. Exptl. Agri. Animal Husbandary. 5: pp. 305-309.

Davidar, P. 1978. Notes on the host plants of the Loranthaceae in the Nilgiris. J. Bombay Nat. Hist. Soc. 75: pp. 1246-1253.

Davidson, D.A.G. 1945. Loranthus attack in sal plantations. Indian For. 71: pp. 181-182.

Davidson, N.J., True, K.C. and Date, J.S. 1989. Water relations of the parasite host relationship between the mistletoe, *Acreuthobium linophyllum* (Fenzl) Tiegehem and *Casuarina obesa* Miq. Oecologica. 80: pp. 321-330

De, R.N. 1941. Loranthus attack in Sal plantations. Indian For. 71: pp. 349-350.

*Dermine, E. 1966. Chemical weed control in apple and pear orchards. Fruit belge. 34: pp. 103-107.

*Easu, K. 1969. The Phloem (Handbuch der Pflanzenanatomie) Vol. 5, part 2. Berlin. Gerbunder Borntaeger.

Ebleringer, J.R., Schulze, E.D., Zlegler, H., Farquahr, G.D. and Lange, O.L. 1985. Water use efficiency and carbon isotope ratio in Mistletoes and their hosts Bull Ecol. Soc. of America. 66: p. 169.

*Fer, A. 1981. Transport pathways involved in nutrient supply of phanerogamous parasitic plant. Study with detached leaves parasatized by cuscuta. Physiologic Vegetale. 19: pp. 177-196.

*Fisher, J.J. 1983. Water relations of mistletoes and their hosts. In: The biology of mistletoes D. M Calderad P. Bernhardt : pp. 161-184.

Frochot, H., Pitsch, M. and Webrlen, L. 1983. Herbicide efficiency in mistletoe (Viscum album Mali) growing on poplar. New Zealand J. Bot. 22: pp. 399-402.

George, K. 1966. Selective control of Loranthus on Teak. Curr. Sci. 35: p. 444.

Ghosh, S.K. and Balasundaran, M. 1980. A simple technique for injecting chemicals into teak. Curr. Sci. 49: pp. 827-828.

Ghosh, S.K., Balasundaran, M. and Mohammed Ali, M.I. 1983. Possible teak mistletoe control through trunk injection of weedicides Proc. X. Int. Cong. Plant. Prot., Brighton, England. : pp. 21-25.

Ghosh, S.K., Balasundaran, M. and Mohammed Ali 1988. Towards the control of mistletoe on teak through injection using weedicides - Trends in Tree Sciences P.K. Khosta and R.N. Sehgal. (eds.) : pp. 185-192.

Ghosh, S.K., Balasundaran, M. and Mohammed, M.I. 1984. Studies on the host parasite of phanerogamic parasites on teak and possible control. KFRI Res. Rep. 21: p. 39.

Glatzel, G. 1983. Mineral nutrition and water relations of hemiparasitic mistletoes. A question of partitioning. Experiments with Loranthus europaeus on Quercus petraca and Quercus robur Oecologica. 56: pp. 193-201.

Gnanaharan, R., Ghosh, S.K. and Balasundaran, M. 1983. Effect of mistletoe on the strength property of Tectona grandis L. Mater Org. 3: pp. 213-219.

Gopalakrishnan, M., Sundarababu, P.C., Venugopal, M.S. and Gopalan 1979. Padding method of application for the control of mango stem borer (Batocera refomaculata) S. Indian Hort. 27: pp. 12-14.

Govier, R.N., Nelson, M.D. and Pale J.S. 1967. Hemiparasitic nutrition in Angiosperms. The transfer of organic compounds from host to odonitites verna (Belt) Dum. (Scrophularacea). New Phytol. 66: pp. 289-297.

Gregory, G.F., Jones, F.W. and Mowain. 1973. Pressure injection of MBC-HCL solution as a control for Dutch elm disease USDA Forest Service Res. Notes : p. 176.

Hawksworth, F.G. 1978. Biological factors of dwarf mistletoe in relation to control. In: Proc. Symp. Dwarf mistletoe control though forest management, berkeley, California. General Tech. Rep. Pacific South West forest and range experiment station. No. PSW. 31: pp. 5-15.

Hawksworth, F.G. 1983. Mistletoes as forest parasites. In: The Biology of Mistletoes. D.M. Caderod and P. Bernardt (eds.) : pp. 317-333.

Heidmann, L.J. 1977. Silvicultural control of dwarf mistletoe in South Western ponderosa pine. Research note, Rockey mountain forest and range Experiment station. No. PSW - 31: pp. 5-15.

Horsfall, J.G. and Cowling, E.B. 1977. The sociology of plant pathology. Plant Diseases. in Horsfall and cowling, (eds.) An Advanced Treatise. Academic Press. Vol I: pp. 11-33.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi. 2nd Ed. p. 498.

Jhonson, A.J., Alfaro, R.I., Bloomberg, W.J. and Smith, R.B. 1985. Impact of dwarf mistletoe on the growth of Western Hemlock trees having different patterns of suppression and release. Canadian J. For. Res. 15: pp. 665-668

Johnson D.W., Hawksworth, F.G. and Dremmasd, D.B. 1981. Yield loss of lodgepole pine stands to Wyoming national forests. U.S. Forest service. Rocky mountain Region, Forest Pest Management Technical Report. 32: p. 10.

Johri, B.M. and Bhatnagar, S.P. 1972. Loranthaceae - Botanical Monograph No. 8: pp. 125-155.

*Jordan, L.C. and Caseley, J.C. 1968. The effect of herbicides on fruit plants. Proc. Symp. Br. Weed control coun. Herbcides in British fruit growing : pp. 81-100

Kadambi, K. 1954. On Loranthus control. Indian For. 80: pp. 493-495.

Knutson, D.M. 1979. How parasite seed plants induce disease in other plants. In: Plant Disease An Advanced Treatise. J.G. Horsfall and cowling, E.B., (eds.) New York Academic Press. 4: pp. 293-312.

Knutson, D.M. 1983. Physiology of mistletoe parasitism and disease response in the hosts. In : The Biology of Mistletoes. D.M. Catderad and P. Bernhardt. (eds.) pp. 295-316.

Kumar, N.C. and Mukherjee, K.L. 1973. Host parasite relation in D. falcata infection Indian Phytopath. 26: pp. 148-152.

Kuijit, J. 1955. Dwarf mistletoe Bot. Rev. 21: pp. 569-626.

Kuijit, J. 1969. The biology of parasitic flowering plants. UNN: Calif. Press Berkeley: p. 246.

*Kuijit, J. and Mulder, D. 1985. Mistletoes Parasitic on Orchids. American Orchid Society Bulletin. 54: pp. 976-979.

Lamont, B.B. and Southal, K.J. 1982. Distribution of mineral nutrients between the mistletoe Amyema preissii and its host Acacia acuminata. Annals of Botany. 49: pp. 721-725.

Land-Hoie, K. and Rognstad, A. 1990. Stump treatment with imazapyrand glyphosate after cutting hard woods to prevent regrowth of suckers. Crop Protection. 9: pp. 29-31.

Leonard, O.A. 1972. Peculiar and Pesky weed that's mitletoe Weeds Today. 3: pp. 8-9.

Litcher, J.M., Reid, M.S. and Berry, A.M. 1991. New methods for control of leafy mistletoe (Phoradendron Spp.) on land scape trees. J. Arboriculture. 17: pp. 127-130.

Luckwill, L.C. and Casely, J.C. 1966. The effect of herbicide on fruit plants. Proc. Symp. Weed. Control: pp. 81-100.

*Lushington, P.M. 1898. Report and Working Scheme of the Nilambur Teak Plantations. Govt. Press, Madras p. 12.

*Mathiasen, R.L.S., Hawksworth, F.G. and Edminister, C.B. 1990. Effects of dwarf mistletoe on growth and mortality of Douglas fir in the South West - Great Basin. Naturalish. 50: pp. 173-179.

Maraveva, D.A., Popura, O.I. and Gasparyan, K.O. 1990. Glucosamine of the poly saccharide fractions from mistletoe and the Chinese parasol tree - Chemistry of Natural Compounds. 26: pp. 705-706.

Minko, G. and Fagg, P.C. 1989. Control of some mistletoe Spp. on Eucalyptus by trunk injection with herbicides. Australian Forestry. 52: pp. 94-102.

Muthanna, M.A. 1955. Letters to the editor, Indian For. 82: p. 268.

Nair, N.G. 1965. Studies on the control of Loranthus elasticus desrouss. parsatizing Mangifera indica using 2, 4-D. Agric. Res. J. Kerala. 3: pp. 29-31.

Natarajan, K. 1990. Effect of padding for the control of wooly aphis on apple and its influence on the parasite, Aphlelinus mali Haldemann. S. Indian Hort. 38: pp. 270-271.

Nicholson, D.I. 1955. The effect of 2, 4-D injections and of mistletoe on the growth Eucalyptus polyanthemos Australian For. Timber Bur. Leaflet. 69: p. 19.

Onofeghara, F.A. 1981. Mistletoe parasitism in West Africa. In Abstracts; XIII International Bot. Cong. Sydney, Australia, August 1981: p. 322.

Osman, A. Sidahmed 1984. Incidence of mistletoe (Loranthus spp.) on citrus and guava trees in the central region of the Sudan. Tropic. Hort. 8: pp. 417-419.

Parker and Wilson, A.K. 1985. Parasitic weeds and their control in the Near East. Paper presented at the FAO expert consultation on improved weed management in the Near East, Cyprus: p. 265.

Pundir, Y.P.S. and Mishra, A.K. 1979. Cryptolepis buchanani (Asclepiadaceae) - A new host for Scurulla pulverluenta. (Loranthaceae). J. Indian. Bot. Soc. 58: pp. 129-139.

Prasad, R. 1975. Development of a modified low pressure trunk-injection apparatus for prevention of the Dutch Elm disease in large Elm trees. Chemical control research institute, Ottawa Ontario. Report - cc 114 p. 18.

Rao, N.N.R. and Singh, S.J. 1991. Betel vine - a new host record of D. falcata Indian. Phyto. Path. 44: p. 419.

Rao, P.S.J. 1923. A note on South Indian Loranthaceae and their host plants. Indian Hort. 49: pp. 416-428.

Ravindran, C.S. 1976. Chemical control of weeds in transplanted rice during third crop season. M.Sc. (Ag.) thesis submitted to Kerala Agric. University. Vellanikkara (Unpublished).

Reghupathy, A., Rajukkanu, A., Kuttalam. S., Parameswaran A. and Arumugam, A. 1989. Residues of monocrotophos applied as trunk implantation to coffee plants. S. Indian Hort. 37: pp. 355-356.

Rey, L., Sadik, A., Fer, A. and Renaudin, S. 1991. Trophic relations of the dwarf mistletoes Acreuthobium oxycedri with its host Juniperus oxycedrus J. Pl. Physiol. 138: pp. 411-416.

Saivaraj, K., Habebulla, B. Gunahilayaraj, K., Mohansundaram, K. and Balasubramanium, P. 1982. Insecticide residue in mango. S. Indian Hort. 30: pp. 40-42.

Scharpf, R.F. and Parmeter J.R. 1978. Dwarf mistletoe control through forest management. Pacific South west forest and range expt. station, General Techn. Rep. PSW 31: p. 190.

Seth, J.N. 1958. Comparative effect of certain herbicides on banda and its hosts. Science and Culture. 23: pp. 424-426.

Sharma, S.K. 1990. Dendrophtoe falcata attacks Boswellia Serrata. Indian For. 116: pp. 253-254.

Simpson, J.E., Adair, C.R., Kobler, G.O., Dawson, B.H., Debald, H.A., Kaester, E.B. and Klick, J.T. 1965. Quality evaluation studies of foriegn and domestic races. Tech. Bull. 1331. Service USDA: pp. 1-180.

Singh, B. 1952. Morphology and embryology of D. falcata (L.f) Ettingsh. J. Linn. Soc. Botany. 52: pp. 424-426.

Singh, B. 1954. Studies on the family Loranthacea. List of new hosts of D. falcata (L.f) Ettingsh its relation with hosts, the anatomy of its seedlings and mature haustorium. Agra Univ. J. Res. 3: pp. 301-315.

Singh, B. 1962. Studies in angiospermic parasites. Bull Nat. Bot. Gardens. 69: p. 75.

Singh, J. Pant, R.C. and Rao, P.B. 1991. Two new hosts of D. falcata (Linn. F) Ettingh Indian J. For. 14: p. 155.

Singh, P. and Carew, G.C. 1989. Impact of eastern dwarf mistletoe in black spruce forests of New found land. European J. For. Path. 19: pp. 305-322.

Singh, R.S. 1983. Phanerogamic plant parasites. In: Plant diseases - fifth edition. Oxford and IBH Publishing Co. New Delhi. pp. 546-548.

Sridhar, T.S. and Rama Rao. 1978. D. falcata a menace to fruit orchards. Curr. Sci. 47 (23): 908 pp.

Srivastava, L.M. and Esaui, K. 1961. Relation of dwarf mistletoe to the xylem tissue of conifers II. Effect of the parasite on the xylem anatomy of the host Am: J. Bot. 48: pp. 209-215.

Stewart, J.L. 1978. Overview of the dwarf mistletoe problem. Proc. Symp. Dwarf mistletoe control through forest management. Gen. Tech. Rep. PSW. 31: pp. 2-4.

Surya Prakash, Krishnan, P.S. and Tewari, K.K. 1967. Biochemical aspects of parasitism by the angiosperm Parasites 1. Phosphate fractions in the leaves of Loranthus and hosts. Pl. Physiol. 42: pp. 347-351.

Thomas, M.O. 1960. Chemical weed control in limes, avocados and mangoes Ref. Flaaric exp. stn. p. 370.

Thoday, 1961. Modes of union and interaction between parasite and host in the loranthaceae. Proc. R. Soc. London. 145: pp. 531-548.

Thompson, A.J., Smith, R.B. and Alfaro, R.I. 1985. Growth patterns in immature and mature western hemlock stands infected with dwarf mistletoc. Canadian J. For. Res. 14: pp. 518-522.

* Orginals not seen

APPENDICES

Appendix - I

Weather data for the past five years of Vellayani

Month	Temperature (^oC) Maximum	Minimum	Relative Humidity (%)	Total Rainfall (mm)
JAN-1988	31.0	20.9	83.10	0
FEB-1988	32.2	22.3	78.41	6.6
MAR-1988	33.1	24.9	71.24	55.3
APR-1988	32.8	24.7	78.63	62.8
MAY-1988	32.6	25.5	78.90	51.2
JUN-1988	30.0	23.7	78.74	307.0
JUL-1988	30.5	23.4	75.69	197.8
AUG-1988	30.6	23.0	75.95	100.3
SEP-1988	29.7	23.5	79.28	320.6
OCT-1988	31.6	24.0	74.70	11.6
NOV-1988	31.1	23.0	71.58	78.8
DEC-1988	31.7	22.3	70.03	6.4
	31.4	21.36	76.35	1198.4
JAN-1989	33.6	21.8	73.95	4.4
FEB-1989	31.80	20.9	78.20	0
MAR-1989	32.84	23.11	70.35	43.3
APR-1989	32.0	24.52	75.58	129.2
MAY-1989	31.5	25.1	71.94	108.4
JUN-1989	28.35	23.68	80.02	347.4
JUL-1989	31.17	24.2	88.8	215.2
AUG-1989	29.1	23.3	84.26	89.4
SEP-1989	29.4	23.5	82.3	222.8
OCT-1989	29.7	23.5	84.5	195.3
NOV-1989	30.85	23.4	78.66	100.11
DEC-1989	31.1	22.9	67.85	31.5
	30.95	23.33	71.39	1487.01
JAN-1990	30.14	22.8	75.97	3.6
FEB-1990	32.27	22.61	85.74	0
MAR-1990	33.02	25.0	91.26	12.8
APR-1990	33.49	25.62	95.55	17.6
MAY-1990	31.48	24.30	84.58	370.1

Contd....

Month	Temperature (^oC) Maximum	Minimum	Relative Humidity (%)	Total Rainfall (mm)
JUN-1990	30.0	24.30	84.89	147.2
JUL-1990	29.22	23.10	82.43	229.3
AUG-1990	30.47	23.55	79.11	27.9
SEP-1990	30.80	23.99	77.46	78.2
OCT-1990	30.34	23.23	81.62	110.3
NOV-1990	30.14	23.27	81.58	524.8
DEC-1990	31.01	22.78	78.10	22.9
	31.03	23.74	83.19	1544.7
JAN-1991	30.8	22.3	77.8	28.6
FEB-1991	31.1	21.3	71.2	26.5
MAR-1991	32.3	23.98	76.1	40.0
APR-1991	33.4	25.4	78.7	31.2
MAY-1991	33.2	25.75	78.66	87.4
JUN-1991	29.5	24.0	88.2	669.3
JUL-1991	29.4	23.47	83.5	272.0
AUG-1991	29.4	23.4	80.7	154.5
SEP-1991	36.7	24.1	76.9	22.4
OCT-1991	30.8	23.7	86.5	205.8
NOV-1991	30.2	23.2	81.6	247.1
DEC-1991	30.4	21.9	74.3	20.0
	31.43	23.54	79.51	1532.83
JAN-1992	30.29	20.4	72.5	35.0
FEB-1992	30.87	21.9	73.64	0
MAR-1992	32.06	22.22	71.34	0
APR-1992	33.00	25.40	75.90	6
MAY-1992	31.72	24.95	80.02	90.9
JUN-1992	29.80	24.20	83.13	613.3
JUL-1992	28.9	23.00	83.84	224.7
AUG-1992	28.9	23.3	85.18	67.8
SEP-1992	29.3	23.2	84.5	76.3
OCT-1992	28.9	22.7	79.90	412.0
NOV-1992	29.17	23.0	82.53	281.0
DEC-1992	30.34	21.48	78.58	151.0
	30.27	22.98	79.26	1822.1
JAN-1993	30.31	20.56	76.85	0
FEB-1993	31.2	21.31	78.43	2.8

Appendix - II

Cost of operations by chemical control of Loranthus in mango orchards
(Rs. ha^{-1} yr^{-1})

Chemicals	Cost of chemicals (Rs.)		Cost of application (Rs.)		Total cost (Rs. ha^{-1} yr^{-1})	
	Padding	Infusion	Padding	Infusion	Padding	Infusion
Sim azine	0.06	0.06	1623	2647	1623.06	2647.06
Atrazine	0.06	0.06	1623	2647	1623.06	2647.06
Glyphosate	0.15	0.15	1623	2647	1623.15	2647.15
Dalapon	0.06	0.06	1623	2647	1623.06	2647.06

APPENDIX - III

Cost of operations by cultural control of Loranthus in mango orchards

(Rs. ha^{-1} yr^{-1})

Treatments	Cost of labour (Rs.)	Total Cost (Rs. ha^{-1} yr^{-1})
T_1	5904	5904
T_2	2952	2952

CONTROL OF PHANEROGAMIC PARASITES INFESTING MANGO

BY

RASHMI C. R.

ABSTRACT OF THE THESIS
submitted in partial fulfilment of the requirement
for the degree
MASTER OF SCIENCE IN AGRICULTURE
(AGRONOMY)
Faculty of Agriculture
Kerala Agricultural University

Department of Agronomy
COLLEGE OF AGRICULTURE
Vellayani, Thiruvananthapuram

1993

ABSTRACT

To study the intensity of infestation of Loranthus and to suggest its control measures in mango orchard, survey and field experiments were conducted during 1992-93. The survey was carried out in three D.A.F. viz., Peringamala, Anchal, Mavelikkara and Instructional Farm, attached to the College of Agriculture,Vellayani. It was revealed from the survey that the Loranthus species _Helicanthes elastica_ was attacking the mango orchards in all the locations of southern Kerala. It was also noticed that the rate of infestation of the parasitic weed was greater in older orchards than in younger ones. Out of the eight common varieties cultivated in all the locations, Bangalora variety recorded relatively lesser infestation than others.

The field experiments were confined to Instructional Farm College of Agriculture, Vellayani. The experiment pertaining to the cultural control measures had three treatments viz., clearing of the parasite once in three months (T_1) clearing of the parasite once in six months (T_2) and unweeded control (T_3), with six replications tested in a Randomized Block Design. Frequent lopping of the parasite as administrated in T_1 recorded the least number of the infestations, biomass and carbohydrate uptake compared to T_2. The number of haustoria spread of infestation, nutrient

uptake and protein uptake were found to be comparable between T_1 and T_2. T_2 was found to be more economical than T_1.

The chemical control experiments comprised of four herbicides viz., Simazine 10 mg a.i per litre (C_1), atrazine 10 mg a.i per litre (C_2), glyphosate 10 mg a.i per litre (C_3) and dalapon 10 mg a.i per litre (C_4) with two methods of application viz., padding and infusion with three replication in a Randomized Block Design. Infusion of all the herbicides invariably recorded its superiority in controlling the parasite than by padding. Among the four herbicides tried atrazine and glyphosate appreciably controlled the number of infestations, spread of infestation and biomass of the parasite. The uptake of nutrient, carbohydrate and protein by the parasite was also reduced by the application of atrazine and glyphosate. Infusion of atrazine and glyphosate was found to be the best treatment in controlling parasite growth and development. No visual symptoms of toxicity was found on the host after the application of any of the herbicides. Residual content of atrazine in the mango fruits was found to be below the toxicity level.